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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)

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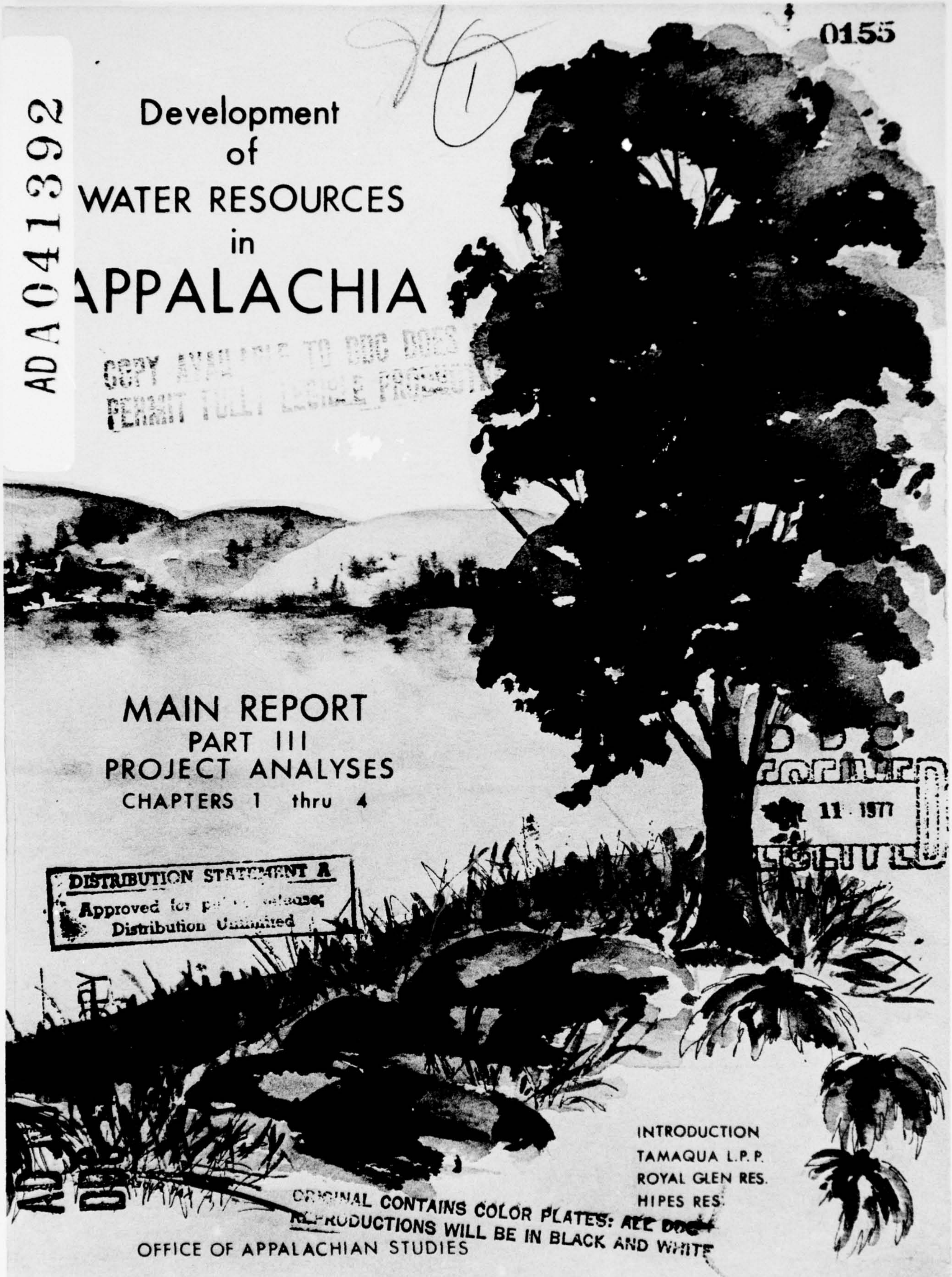
Development of WATER RESOURCES in APPALACHIA



MAIN REPORT
PART III
PROJECT ANALYSES
CHAPTERS 1 thru 4

INTRODUCTION
TAMAQUA L.P.P.
ROYAL GLEN RES.
HIPES RES.

OFFICE OF APPALACHIAN STUDIES

CORPS OF ENGINEERS

U. S. ARMY

DEPARTMENT OF THE ARMY
OFFICE OF APPALACHIAN STUDIES. CORPS OF ENGINEERS
P. O. BOX 1159
CINCINNATI. OHIO 45201

TO: THE READER

This volume ~~(Number 6)~~ is one of six that comprise Part III, "Project Analyses", to the Main Report for Development of Water Resources in Appalachia. The volume contains four of the Part's 20 chapters.

Each chapter generally contains information on how the project was formulated and designed; its estimated costs; the type and value of benefits expected; and the indices of performance. Also included, as appropriate, is information on sharing of project costs among Federal and non-Federal interests, coordination carried out during the planning process, and conclusions reached. See Part II, Sub-Regional Plans, for the economic impact of each project on the region.

Chapter 1, Section I, of this volume is an introduction to all of Part III. Section II of Chapter 1 is a revised and updated summary of the previously submitted interim survey report on Upper Licking River Basin, Kentucky, prepared by the U.S. Army Corps of Engineers, Louisville District, which proposes the Royalton Reservoir-Salyersville Area Project. Copies of the interim survey report, which is now a supplement to this volume of the report, are available to the reader from the Louisville District at a cost of $9.00 per copy. Chapter 2, Tamaqua Local Protection Project, prepared by the U.S. Army Engineer District, Philadelphia, formulates a plan to provide adequate flood protection in the Borough of Tamaqua, Schuylkill County, Pennsylvania. Chapter 3, the Royal Glen Reservoir Project, prepared by the U.S. Army Engineer District, Baltimore, presents a plan for a multiple purpose project on the South Branch Potomac River just above Petersburg, West Virginia, which would be an integral part of the Spruce Knob-Seneca Rocks National Recreation Area. Chapter 4, Hines Reservoir Project, prepared by the U.S. Army Engineer District, Norfolk, formulates a plan for a multiple purpose reservoir on Craig Creek, about 25 miles north of Roanoke, Virginia.

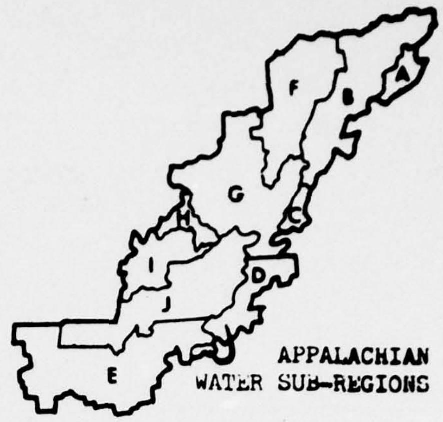
The Summary Report (Part I, Volume 1) should be consulted for recommendations made as a result of the information presented in this volume. A volume index for the Main Report and its nine supporting Appendices is included on the next two pages for your convenience.

John C. H. Lee

JOHN C. H. LEE, JR.
Colonel, Corps of Engineers
Director

REPORT
For
DEVELOPMENT OF WATER
RESOURCES IN APPALACHIA

VOLUME INDEX



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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

VOLUME 6

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2. TAMAQUA, PENNSYLVANIA LOCAL PROTECTION PROJECT
3. ROYAL GLEN RESERVOIR PROJECT, WEST VIRGINIA
4. HIPES RESERVOIR PROJECT, VIRGINIA

* The Interim Report, Upper Licking River Basin, Kentucky, is Available as a Supplement to Volume 6 from the U.S. Army Engineer District, Louisville.

Office of Appalachian Studies

Corps of Engineers

October 1969

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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA.

Main Report.

Part III. Volume 6.

PART III - PROJECT ANALYSES.

CHAPTER 1 thru 4.

11 Oct 69

12 426p.

INTRODUCTION

(Including Royalton Reservoir-Salyersville

Area Project Summary)

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October 1969

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PROJECT ANALYSES

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PART III
PROJECT ANALYSES

CHAPTER I - INTRODUCTION
SECTION I - COMPOSITION AND USE

1. COMPOSITION

This part (Part III) of the main report provides details on, and economic evaluations of 19 project plans developed in the course of this study. One additional project, a reservoir system on the Greenbrier River, West Virginia, has been planned for inclusion as Chapter 12 but has been deleted for reasons stated in the summary now included as Chapter 12.

Of the 19 project studies, fifteen were prepared by the Corps of Engineers, two by the Tennessee Valley Authority and two by the Commonwealth of Pennsylvania. Corps projects are presented in volumes 6 thru 10. These include two local protection, one navigation and 13 multiple purpose reservoir projects. TVA projects are presented in volume 11 and consist of a multi-element plan for the Upper French Broad River Basin of North Carolina, and a port development project on the Tennessee River in Mississippi. Two studies prepared by Pennsylvania are also included in volume 11. These two projects are water related and have much developmental promise.

2. USE

These project analyses are the bases, and provide the necessary support, for the recommendations contained in Chapter 12 of the Summary Report (Part I). However it must be noted that values for both costs and benefits presented in Part III are based on interest rates applicable at the time each study was completed. This is in contrast with values used throughout Part I which generally reflect currently applicable rates. As a general rule, the rate used in Part III is 3-1/4 percent*/ while that used in Part I is 4-7/8 percent. As a result of the changed interest rate, the indices of performance are usually higher in the Part III chapters than those presented in Part I.

Section II Chapter 1 is a revised and updated summary of the previously submitted interim survey report on Upper Licking River Basin, Kentucky, which proposes the Royalton Reservoir-Salyersville Area Project. The original report, as submitted, plus the views of the Board of Engineers for Rivers and Harbors and the Chief of Engineers is now considered to be a supplement to Part III, Volume 6; however, it is not physically bound herein. A note will be inserted in all available copies of the interin report to cite its inclusion as a unit in the report for Development of Water Resources in Appalachia.

*/ Exceptions are Royalton-Salyersville Area Project, presented at 4 7/8 percent and Yellow Creek Port project presented at 4 3/8 percent.

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SECTION II - ROYALTON RESERVOIR - SALYERSVILLE AREA PROJECT

3. REPORT HISTORY

An interim survey report on the Upper Licking River Basin was prepared in 1967 by the U.S. Army Engineer District, Louisville, Kentucky, as a pilot study for the Appalachian Water Resources Survey (AWRS)*/. The purposes of the report were to:

(1) test evaluation procedures for determining the incidence and magnitude of developmental benefits;

(2) test formulation procedures when accelerated regional development is accepted as the primary goal for water resources development;

(3) test methods for cost allocation and altered cost sharing which would be responsive to the goals of accelerated regional development;

(4) utilize an area where considerable hydrologic and other engineering work had been recently completed, and

(5) portray a role in which water resource development can be utilized to stimulate accelerated regional development.

Public notice was issued by the Ohio River Division Engineer on 4 October 1967 and subsequently the report received favorable reviews by the Board of Engineers for Rivers and Harbors, by cooperating Federal agencies and by the Governor of Kentucky. At this stage, it was determined that the report should be held for inclusion in the Appalachian Water Resources Survey since the essential objective of the pilot study had been accomplished within the review process for Corps of Engineers reports.

The following paragraphs summarize the essential points of the report and update the methods utilized for cost allocation.

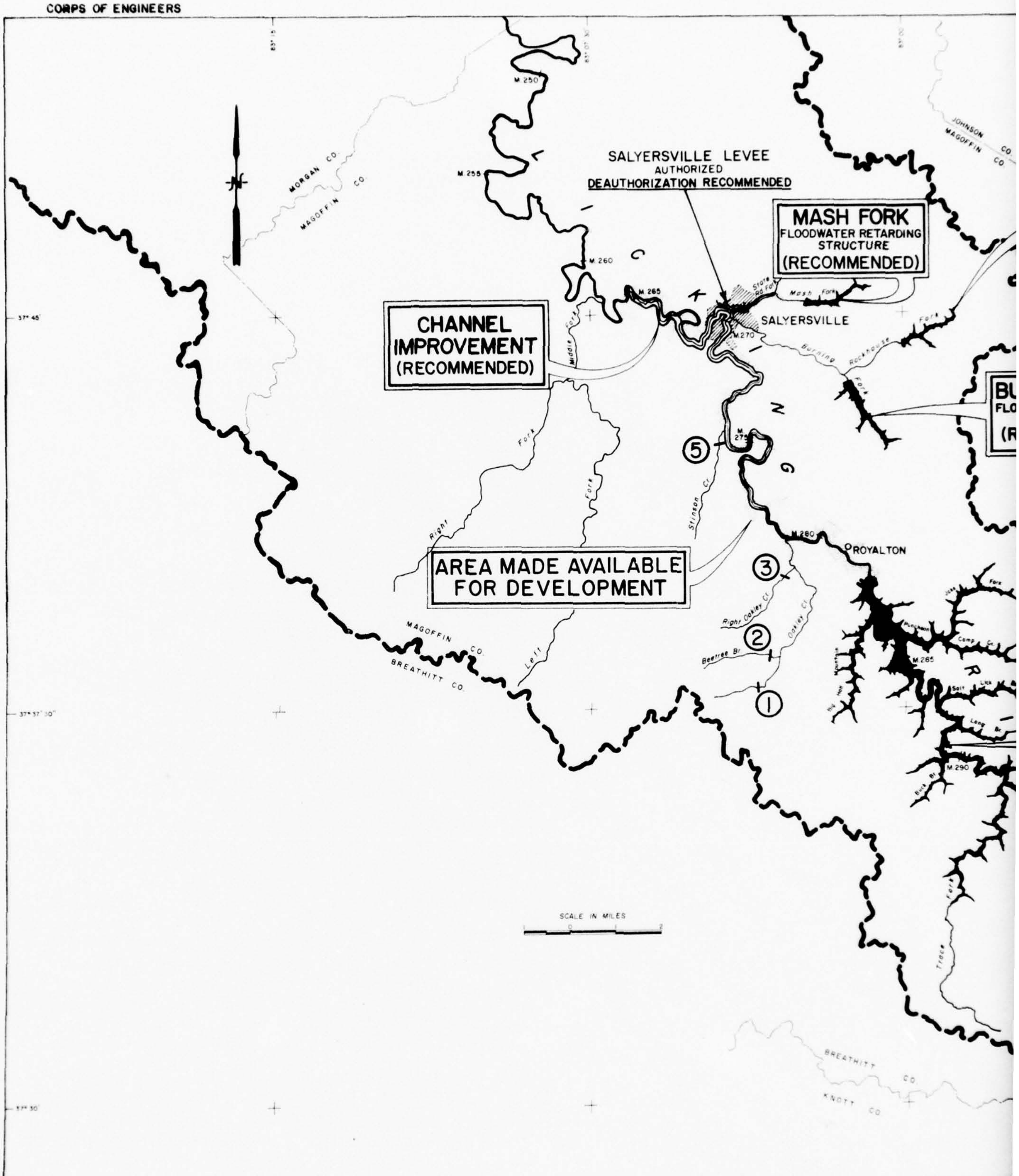
4. BACKGROUND OF THE STUDY AREA

The Salyersville, Kentucky area forms the focus of the investigation reported in this document. A labor market area composed of six eastern Kentucky counties (see figure 1 and exhibit 1) surrounding the Salyersville area represents an area which is experiencing low incomes, high unemployment rates and a more serious underemployment problem. Frequent and persistent flooding has aggregated the economic problems of Salyersville. A local protection project furnishing partial protection to Salyersville was authorized by Section 3 of

*/ Available from Louisville District office at a $9.00 cost.

the Flood Control Act approved August 18, 1941 (PL 288, 77th Congress). The project fails to meet the needs of the locality and has not been supported by local interests. This report acts to reanalyze the water and economic problems of the area to determine if a water control plan can be developed to alleviate the problems in an acceptable manner and provide the basis for accelerated regional development on a long-term basis.

Figure 1. Location of Study Area.


SALYERSVILLE LEVEE
AUTHORIZED
DEAUTHORIZATION RECOMMENDED
MASH FORK
FLOODWATER RETARDING
STRUCTURE
(RECOMMENDED)
CHANNEL
IMPROVEMENT
(RECOMMENDED)
SALYERSVILLE
AREA MADE AVAILABLE
FOR DEVELOPMENT
ROYALTON
MORGAN CO.
MAGOFFIN CO.
JOHNSON CO.
MAGOFFIN CO.
MAGOFFIN CO.
BREATHITT CO.
BREATHITT CO.
KNOTT CO.
M 250
M 255
M 260
M 265
M 270
M 275
M 280
M 285
M 290
Mash Fork
Burning Fork
Rockhouse Fork
Middle Fork
Right Fork
Left Fork
Stinson Cr.
Right Oakley Cr.
Oakley Cr.
Beetree Br.
Salt Lick
Long Br.
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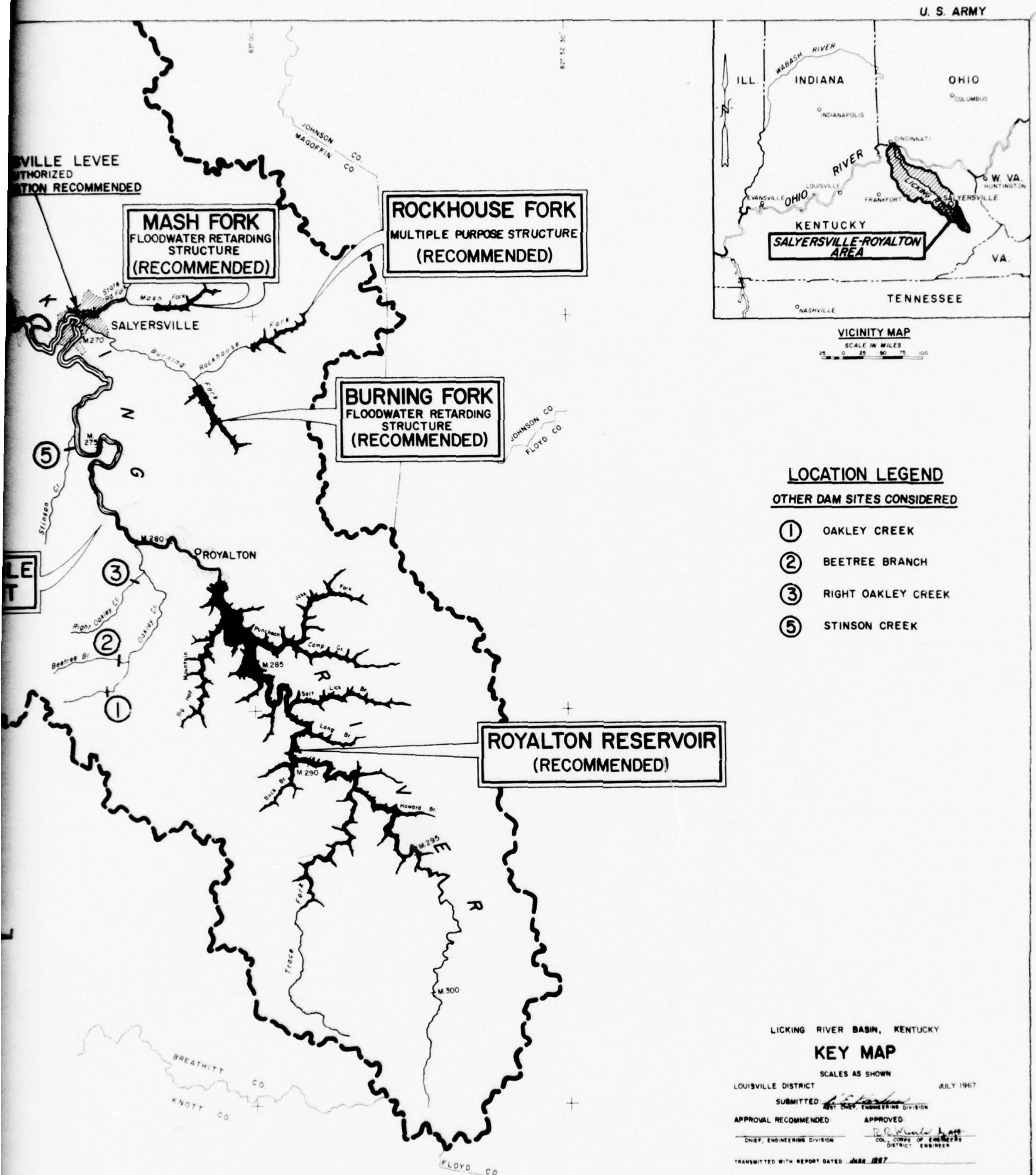
U. S. ARMY
VILLE LEVEE
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MASH FORK
FLOODWATER RETARDING STRUCTURE
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ROCKHOUSE FORK
MULTIPLE PURPOSE STRUCTURE
(RECOMMENDED)
BURNING FORK
FLOODWATER RETARDING STRUCTURE
(RECOMMENDED)
ROYALTON RESERVOIR
(RECOMMENDED)
SALYERSVILLE
ROYALTON
JOHNSON CO.
MAGOFFIN CO.
FLOYD CO.
BREATHITT CO.
KNOTT CO.
M.270
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M.300
ILL.
INDIANA
OHIO
INDIANAPOLIS
COLUMBUS
CINCINNATI
WABASH RIVER
OHIO RIVER
LOUISVILLE
EVANSVILLE
FRANKFORT
W. VA.
HUNTINGTON
KENTUCKY
VA.
TENNESSEE
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2 BEETREE BRANCH
3 RIGHT OAKLEY CREEK
5 STINSON CREEK
LICKING RIVER BASIN, KENTUCKY
KEY MAP
SCALES AS SHOWN
LOUISVILLE DISTRICT
JULY 1967
SUBMITTED:
ASST. CHIEF, ENGINEERING DIVISION
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COL., CORPS OF ENGINEERS DISTRICT ENGINEER
TRANSMITTED WITH REPORT DATED June 1967

EXHIBIT 1

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5. DEVELOPMENT NEEDS

A rapidly expanding national economy requires, and is sustained only when, all parts of the Nation make effective contributions. Increasing demands for goods and services require ever more efficient resource utilizations if national expansion is to continue. Appalachia has noticeably lagged behind the economic performance of the Nation, particularly since 1940. Performance of the study area is even worse. This poor performance is revealed when changes in population, employment opportunities, personal income, health and education services, agricultural output and other measures are compared with the performance of the Nation and adjacent regions. A continuation of these trends of inefficient resource utilization will increasingly retard the potential economic performance of the Nation. A graphic comparison of population and employment changes in the study area with the Appalachian region and the Nation presents the pronounced differences (Figures 2 and 3).

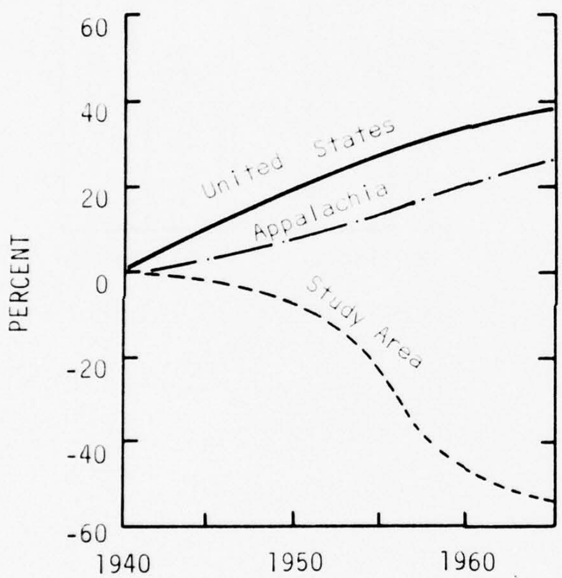

Figure 2. Relative Change in Population since 1940.

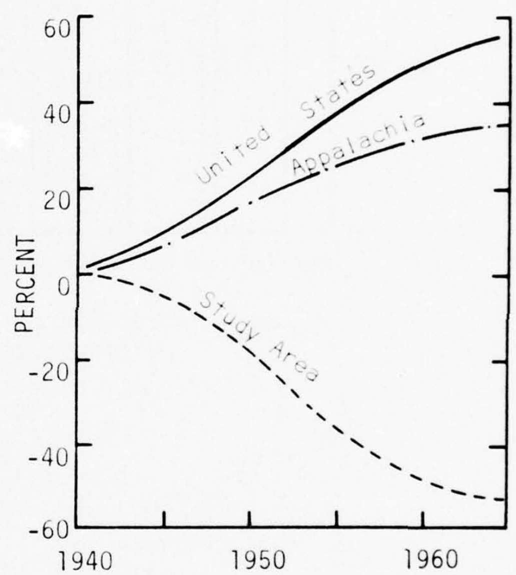

Figure 3. Relative Change in Employment since 1940.

Personal incomes in the study area are very low in comparison with average incomes in the Commonwealth of Kentucky, the Appalachian Region, and the Nation. Wage rates are also significantly lower. A comparison of county and state average wages and personal income is presented in Figure 4. Of the 120 counties in Kentucky, the six forming the study

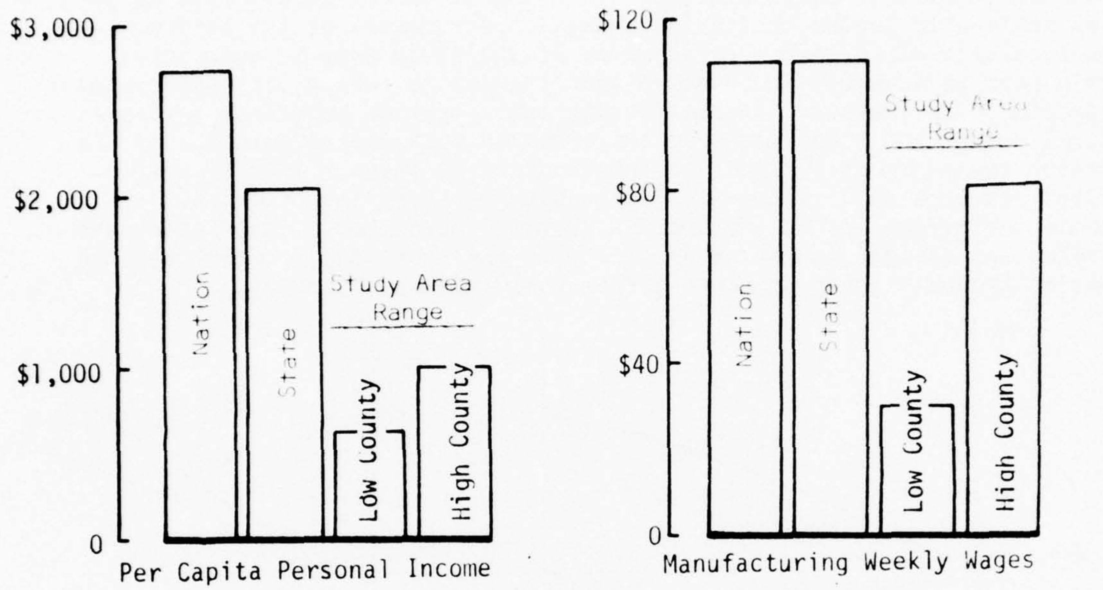

Figure 4. Comparison of Per Capita Personal Income and Manufacturing Weekly Wages (1965).

area rank from 90th to 119th in per capita income. While non-money incomes, such as from subsistence farming and barter, are of greater significance in the study area than for more urbanized and higher income areas, the per capita income comparisons above present a valid ranking and measure of distress.

The study area has a comparatively low level of public services with characteristically low tax base to support additional public investment. The bonding capacity of the area to issue general obligation bonds is sharply limited by the tax base.

The educational level within the study area has been considerably lower than the national average as shown in Figures 5 and 6.

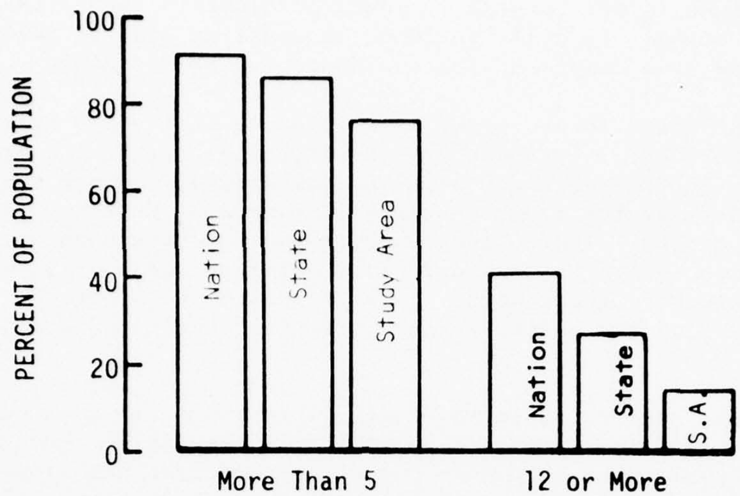

Figure 5. Percent of Population Completing More Than Five and Twelve or More Years of Education.

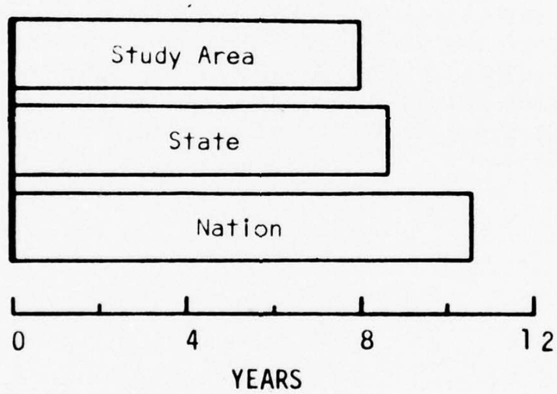

Figure 6. Comparison of Average Education Level in Years.

This comparison is for persons 25 years or older in 1960. Expenditures per school age child in 1966, ranged from $284 to $470 for the study area compared with the State average of $468.

Hospital space in the study area is quite limited in relation to need. There are only about 300 hospital beds within the area or a per capita rate of about 340. By comparison, the per capita hospital bed ratio for Fayette County (Lexington), Kentucky, is 29 persons per bed. There is one doctor per 2,450 persons within the study area. This is considerably lower than urban areas within Kentucky. However, the general level of health of the study area residents is good and health is not presently considered a major problems.

The study area falls in the geologic province known as the Appalachian Plateau. This once nearly level area is now deeply incised by erosion; more than 76 percent of the area has slopes exceeding 15%; valleys are generally narrow, and subject to flash flooding; ridge lines are narrow, seldom suitable for development, and access is difficult from the highway and rail net in the valleys. Thus, major problems that hinder development are lack of developable land and a poor highway system.

Although there are 1.3 million acres of land in the study area, the amount subject to intensive agricultural use is quite limited. This is due to steep slopes in rather shallow upland and generally acid soils. Most of the level land is in flood plains and subject to frequent inundation. Figure 7 depicts the location of major tracts of level land suitable for either industrial or agricultural development if existing physical and economic constraints are removed.

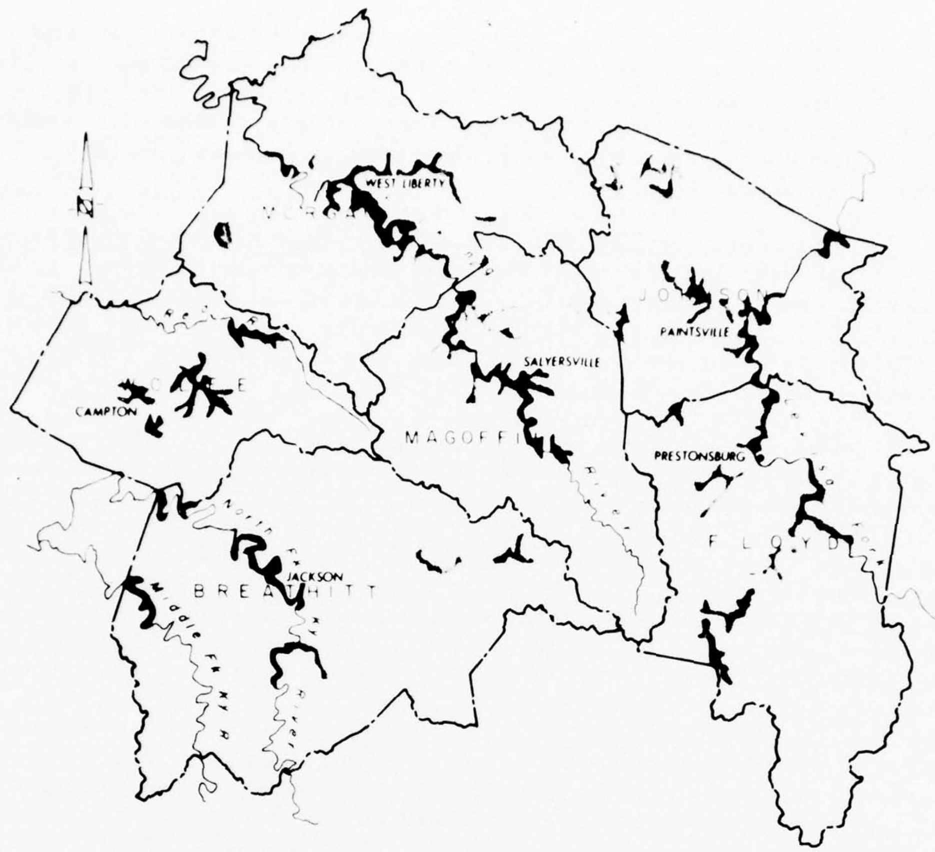

Figure 7. Location of Major Tracts of Land Suitable for either Industrial or Agricultural Development.

Management of the available surface water has been limited in the past to the eastern edge of the study area where control of the Levisa Fork of the Big Sandy River has been partially realized. In most parts of the area water occurs in the wrong places, in the wrong quantities, at the wrong times. The area also experiences periods of water shortage with many streams frequently having very little or no flow. Ground water in the area is limited in quantity and quality with dependable yields among the lowest in the Appalachian Region.

This inadequacy of ground water for other than limited uses stems from the study area's geology which provides none of the better water-carrying strata. Thus it is only in the fault zones that wells for municipal purposes can have reasonable yields. Moreover, ground water is generally mineralized. A case in point is found at Salyersville, where three wells for municipal supply have a combined capacity of 360,000 gallons a day. However, the two furthest from the city (to

the northeast) have been closed as unacceptably saline, and the nearest well has recently exceeded 200 ppm chloride as against the Public Health Service standard of an upper allowable limit of 250 ppm. Thus, dependence on this one increasingly saline well implies that Salyersville may face a critical supply problem, in both quantity and quality.

Historically, major flooding has occurred in the Levisa Fork, Big Sandy River, Upper Licking River, and North Fork of the Kentucky River Basins within the study area. Flood control of the main stem of Levisa Fork has been generally accomplished. Some progress is being made in controlling the North Fork of the Kentucky River. No work has been executed in the Upper Licking Basin.

Prestonsburg, the major urban community of Floyd County is being provided flood protection by the Fishtrap Reservoir now being constructed, and by completed Flannagan and North Fork Reservoirs, in addition to the completed local protection works. Paintsville, the major urban commuity in Johnson County, is likewise being provided flood protection by the above reservoirs, the completed Dewey Reservoir and the recently authorized Paintsville Reservoir. Wolfe County is being provided water control measures through construction of the Red River Reservoir. Flood control measures have been effected at Jackson in Breathitt County. These measures, conisting of channel improvements, reduce the annual flood damages but do not provide a sufficient degree of protection to encourage growth. Reservoirs now being considered upstream from Breathitt County would, if implemented, contribute to an improved condition. The Upper Licking River Basin, lying in Morgan and Magoffin Counties, has no flood control improvements. Average annual flood damages in Licking River flood plain areas from the Salyersville-Royalton area downstream through West Liberty total $183,000.

A major portion of the area is in cut-over forest lands. Historically, production from these lands has contributed significantly to the area's economy. Today, employment in the lumber and furniture industry has declined to less than one percent of total employment in the study area, and replenishment of the forest resource is gradually restoring timber's role in the economy.

The four western counties have been historically dependent on agriculture as the primary source of income. The low levels of income in these counties reflect both the declining share of agriculture in national income and the relatively small size farms that are characteristic of the area.

The major mineral resource in the study area is coal. The two eastern counties have higher per capita incomes than the average of the other four counties. These incomes reflect the increasing mineral productivity in Floyd County, and recent industrialization on flood-free bottom lands in both counties.

In summary, the problems of the study area are those common to much of Appalachia. Slopes are steep, access is difficult, county economies depend largely on coal mining and locations suitable for industrial development are difficult to find. The absence of industrial development in the presence of automation of the mineral industry and the presence of declining forest and agricultural economies are the chief explanations for the depressed conditions as reflected in the low levels of public facilities and services and personal incomes documented above. A major public effort is essential to provide the degree of flood protection required for industrial development of bottom lands.

6. POSITIVE FORCES AT WORK

Resources available in the study area for alleviating the area's problems are described in this section. Several positive economic and institutional forces are already at work in the area.

The Appalachian Regional Development Program with its attendant planning and research activities together with action programs for providing needed public works is a major positive force. The creation of local development districts in the near future will culminate two years of intensive study by the States and the Appalachian Regional Commission into the underlying problems of the Region and the development of suitable programs for their solution. Thus, there is forming in Appalachia a heartening resolve to analyze and identify the basic causes for lagging economic growth, to develop the necessary partnerships at Federal, State and local levels -- and between public and private interests -- and to find effective remedies.

A basic force which can contribute to assisting the Appalachian Region become more competitive with other areas of the Nation grows out of the expanding economy and the increased costs of production in many of the more crowded regions. In such areas the excessive costs to the labor force in commuting to work and in higher prices to maintain a reasonable standard of living are reflected directly in the wages industry must pay. Thus, many industrial sectors are actively seeking to expand into new areas where they will pay a decent wage but not have to pay a premium caused by congestion and prices that do not enhance the workers' standards of living.

In terms of developmental possibilities, the study area's most valuable resource is its potential labor force. Because there has been a lack of job opportunities in the area in the past, there is a significant number of persons who have not entered the labor force. In addition to these potential entrants there is a significant level of unemployment in the existing labor force. The average unemployment rate in the study area for 1962-65 stood at 16.8 percent. Figure 8 depicts the estimated available labor as of June 1966 within the study area.

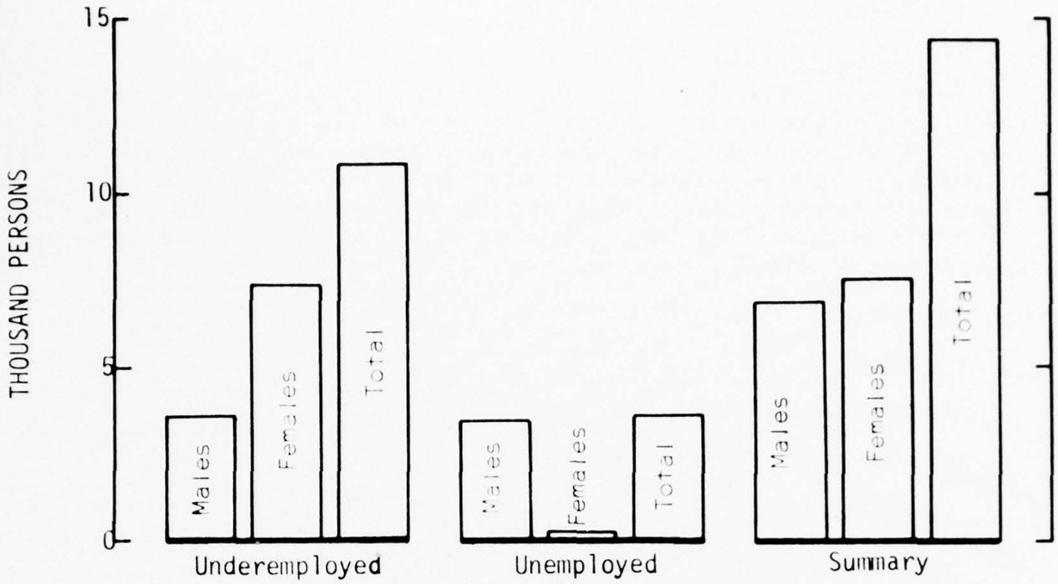

Figure 8. Potential Labor Force Within Study Area (June 1966).

According to Kentucky Department of Security District Office officials, employers are pleased with the quality of their employed workers. Turnover and absenteeism are apparently not problems except perhaps in lumber activities where remuneration is not high but the work is demanding. Employers, particularly in some of the new shoe plants that have opened recently, reported favorably on their predominately female work force which were new entrants. The Ward Manufacturing Company which produces camper bodies for pick-up trucks recently opened a plant in Salyersville. While intending to employ 80-100 people, the company has received 500 applications from the local people. The 20 already hired are reported by management to be performing quite satisfactorily. Out-of-state employers have also registered comments of approval on the quality of the workers coming from this area.

Four state vocational training facilities serve the study area with a wide range of courses designed to provide the student with skills currently in demand. As new demands are identified, a constant flow of trained labor can be provided. An inventory of mechanical skills exists among those underemployed and unemployed persons residing in the area who have acquired experience in metal working and assembly work in northern industrial areas.

Recent trends show a marked, area-wide increase in high school graduates, both numerically and in proportion to total population.

From 1962 to 1964, an average of 36 percent of the high school graduates went on to higher education*/. This compares favorably with the State average of 39 percent.

The local transportation net within the study area needs improvement and the ability of Kentucky's highway system to efficiently connect the study area with outside markets now and in the future is of great economic importance. Major existing and planned highways in these counties are shown in Figure 9. A major feature is the Mountain Parkway, a limited access, state-built toll road which is the first constructed link of what has become the Appalachian Developmental Corridor Systems.

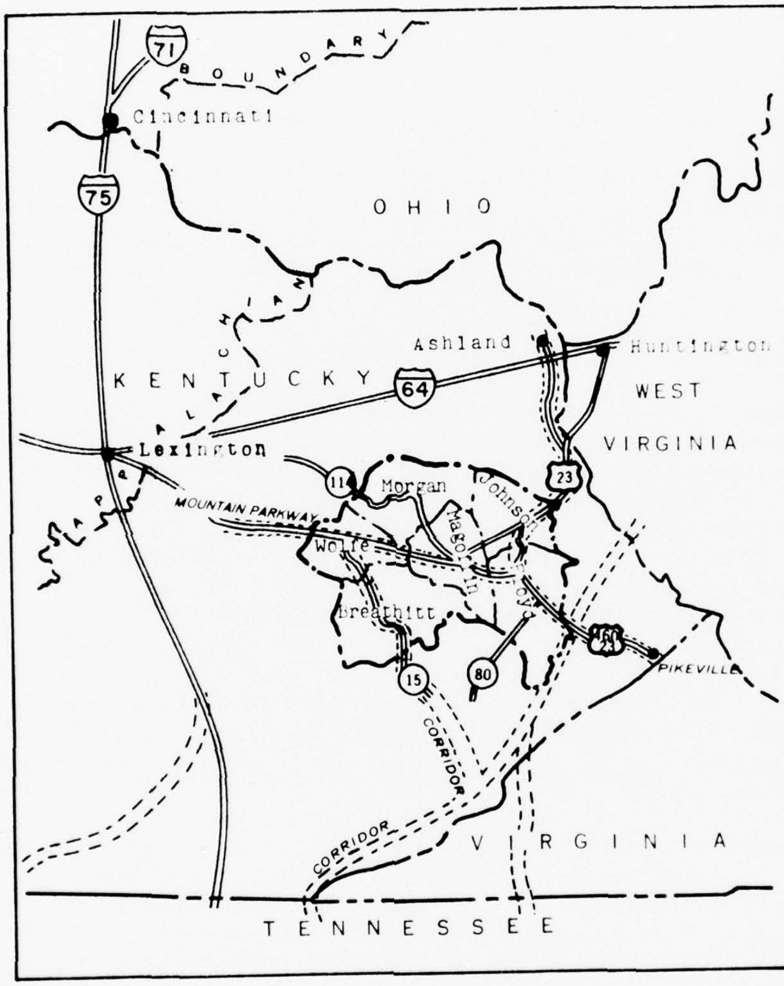

Figure 9. Major Highways and Appalachian Corridors.

*/ Report 222, "Expansion Benefits Analysis for the Salyersville-Royalton Area Pilot Project" - Spindletop Research Center, Lexington, Kentucky, March 1967.

Easy access to major east-west and a north-south interstate highways is considered significant. Two railroads serve the area, one running east-west, the other north-south as shown in Figure 10.

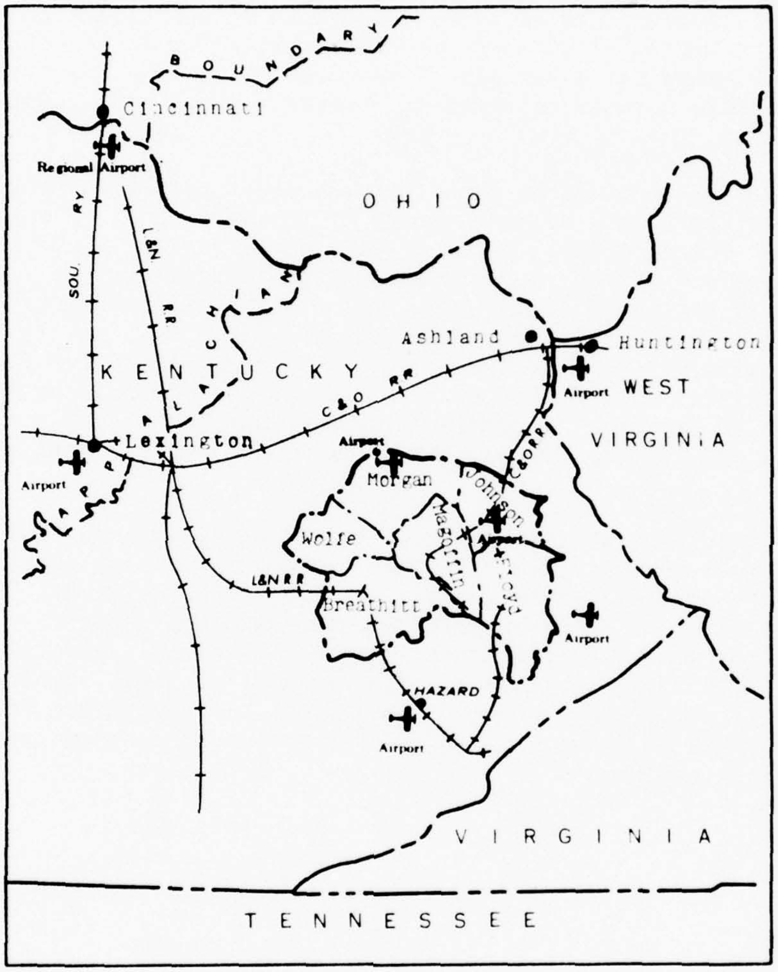

Figure 10. Location of Railroads and Airports.

Delivering time of carload lots to major eastern and mid-western cities from the area is between two and three days. Passenger service is available on the Chesapeake and Ohio line between Lexington and Huntington. Small, unlighted airports exist at West Liberty and Paintsville within the study area. Nearest regularly scheduled air service is at Huntington and Lexington. Locations of these and other airports are shown on Figure 10.

The general availability in the study area of adequate reservoir sites for large, intermediate, and small impoundments offers the prospect for a high degree of water management. Average annual runoff is about 16 inches, however ground water quantities and qualities pose developmental problems. Thus many potentials exist for efficient surface water storage for a variety of purposes as soon as the availability of adequate numbers of users of reservoir goods and services are assured.

The partial development of the water resources of Levisa Fork of the Big Sandy River in the eastern county of the study area -- for the purposes of flood control, water supply, water quality control and hunting, fishing and general outdoor recreation -- provides a clear demonstration of the potentialities in this setting for development which may follow installation of water resource projects. Between 1960, when reasonable flood protection was attained, and 1965*/ Prestonburg and Paintsville have experienced an increase in the tax bases of 60 percent and 10 percent, respectively. Both communities are now experiencing a shortage of developable industrial sites for continued growth.

The most important mineral resource in the study area is coal. Estimated reserves in the six-county area are about 6.4 billion tons of the 74.4 billion tons in the Eastern Kentucky coal fields**/. The substantial majority of these reserves lie in Floyd and Johnson Counties, and include a significant amount of high quality metallurgical coal. Other mineral reserves in the area of economic significance are gas, oil, alluvial clays and sand and gravel. A comparison of the relative importance of mineral production in each county in the study area is depicted in Figure 11.

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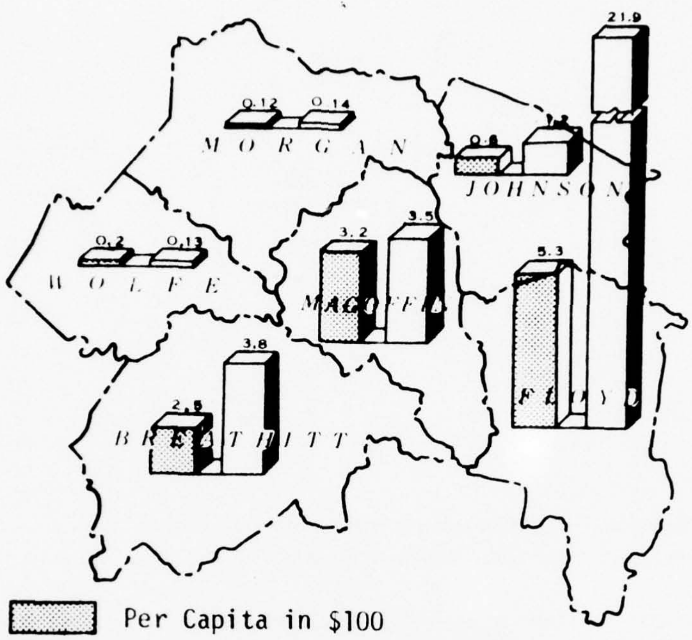
*/ Some of this growth must also be attributed to improved highway access to the north, along U.S. 23, and to the west, along the Mountain Parkway.

**/ Coal Reserves of Eastern Kentucky, U. S. Geological Survey Bulletin 1120, 1963.



Per Capita in $100

Gross Production in $1,000,000

Figure 11. County Income from Mineral Production (1961).

Continued production of coal and other mineral resources will remain a vital part of the study area's economy and earnings. The availability of low cost fuels and other minerals actually adds to the competitive position of the area for attracting private industrial investments. There are no known, essential conflicts between continued mineral production and industrial and water resource developments.

As previously discussed, even with efficient management, the timber resources of the study area can contribute little to early development or growth. Conversely, in spite of poor upland soils, in those areas where bottom lands are freed from flood hazard and not immediately claimed for industrial or related uses, intensive horticulture and truck farming will frequently be possible and would contribute increased earnings to the area for many years.

The ten commercial banks and three savings and loan associations located in the study area (Figure 12) are essential institutions for

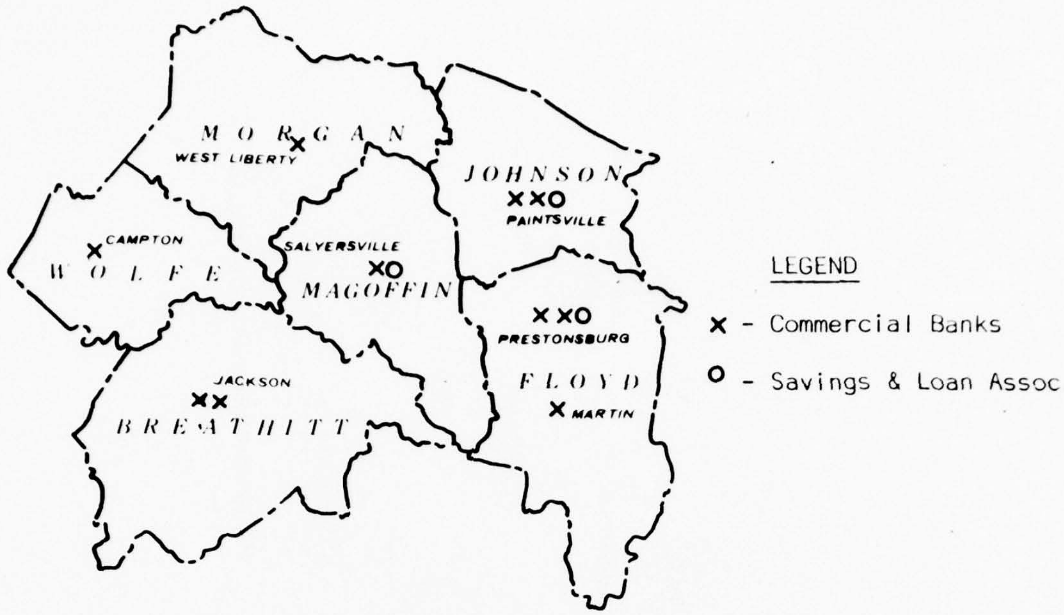


Figure 12. Location of Commercial Banks and Savings & Loan Associations Within Study Area.

the financing required for area-wide development, particularly where special knowledge of local conditions is necessary. Half of the commercial banks are nationally chartered, half are state chartered. All savings and loan associations are federally chartered. On a per capita basis bank deposits amounted to $550 in 1964 compared to the state average of $753. Figure 13 shows the trend in bank deposits for the six-county area. These local sources of capital will be expanded

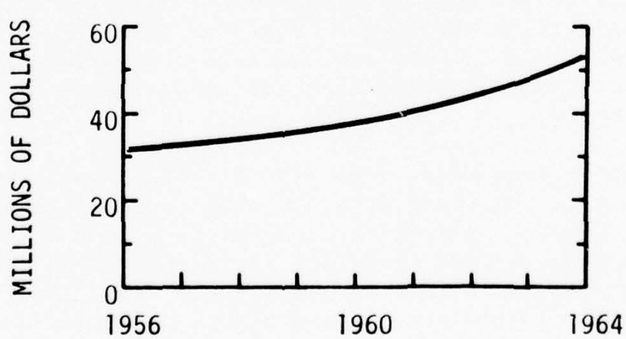


Figure 13. Bank Deposits in Study Area.

as development plans materialize. The growing need for special financial services to serve a developing economy will often attract new capital sources and management through existing financial institutions.

Substantial progress has been made in the study area in both academic and vocational education. There are 145 elementary and 18 high schools within the study area. The Kentucky State Department of Education is currently preparing to implement the second phase of its "Program for Vocational School Systems in Appalachian Kentucky, 1965-71." The State's objective in the field of vocational education is to locate a training program within reasonable commuting distance of every interested citizen. More students from the area are entering college; the percentage of high school graduates from the study area entering college increased from 31.9 percent to 40.5 percent from 1962 to 1964. The University of Kentucky is operating a community college at Prestonsburg. This new college with Lees Junior College at Jackson are within the study area. Morehead State University and Eastern Kentucky State University at Richmond are near the study area. Most students from the study area seeking college education attend these state universities, both of which have grown rapidly in the last decade. Figure 14 shows educational facilities within the study area and distances to other institutions of higher education.

COUNTY	NO. HIGH SCHOOLS	NO. ELEM. SCHOOLS
Morgan	2	12
Wolfe	1	17
Breathitt	1	17
Magoffin	1	24
Johnson	5	26
Floyd	8	49

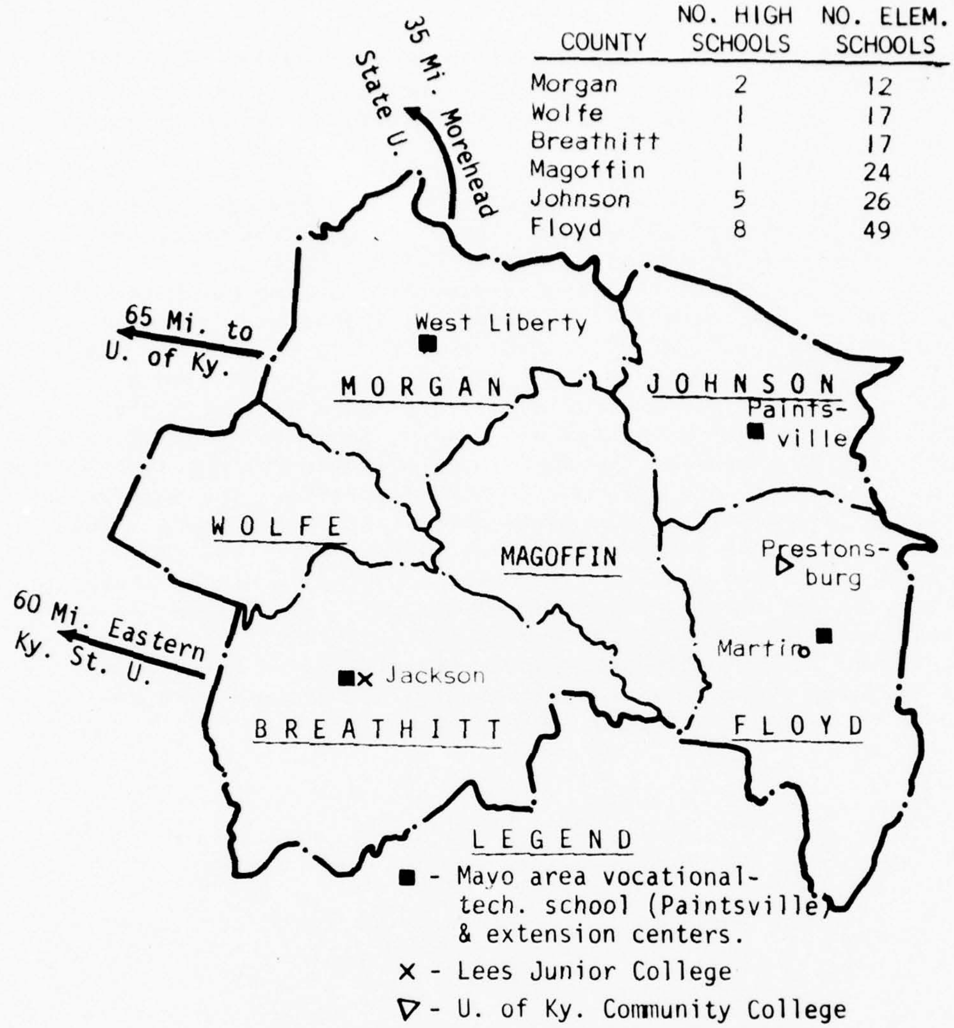


Figure 14. Educational Facilities within Study Area.

Urban services, such as libraries, post offices, fire departments, and police departments would require improvement to serve the expanded economy which is the objective of this development effort. Public utilities, such as gas, power, water supply systems, and sewage treatment facilities would also require expansion.

The study area's total tax base available for bonding in 1966 was $289,391,377. The constitutional bonding debt limit (2%) was $5,787,828 and the 1966 composite debt was $1,206,400. This leaves a total available bonded debt capacity of the study area of $4,581,428. The equalized tax rate per $100 of assessed evaluation for Salyersville was $1.03 in 1965 and for the six counties ranged from $0.56 to $0.94. With industrial, commercial, and residential development an increased tax base would be a considerable resource available for community self-help.

7. FORMULATION AND SELECTION OF PLAN

Water resource needs to stimulate economic expansion in the Salyersville-Royalton area include flood control (to meet present and projected needs), water supply and water quality control to support development and growth and provision of outdoor recreation opportunities to partially meet both present and future needs. The needs have been discussed in the preceding sections of this report and are presented in detail in the appendices.

There are no existing major water resource improvements within the Upper Licking River basin. The authorized, but unconstructed, flood protection levee project for part of Salyersville no longer satisfies the community's needs and is not acceptable to local interests. To meet present and future water resource needs, development of a completely new solution is required. Structural measures such as reservoirs and nonstructural measures such as land treatment can be combined to attain planned objectives. Land treatment measures consist primarily of better forest management and improved agricultural practices. Flood plain management will also be necessary in order to assure orderly development. Water supply and water quality control needs can be met by a reservoir on the main stem of the Upper Licking River. An effective system of projects can be designed to provide water related outdoor recreation opportunities and to provide a degree of protection from flooding which would permit the economical development of the valley for industry, housing, recreation and high value truck crops. In order for this development to take place it was concluded that protection against all floods having an average annual frequency of one or more events per 100 years must be provided.

The scope of significant works of improvement must be such that the water services produce adequate amounts of national and regional benefits stemming, in part, from increased industrialization, more jobs, increased services and other stimulated economic growth and opportunities. There are many combinations of works of improvements that will contribute to a solution of the problems. The objective then is to determine that plan that is functionally efficient and which, by providing a changed environment for growth, maximizes developmental response.

The prime objective of the water related plan developed in this report is to reduce water related impediments to the growth potential of the Salyersville-Royalton Area. An associated objective is to outline an attendant plan of development which can be supported by the water plan and to define a course of implementation of the complementary developmental plan to provide for increased industrial and economic activity in the Salyersville-Royalton area. Specifically, the comprehensive program of development must: (1) Provide an adequate supply of lands reasonably free from flooding; (2) provide water supplies adequate to meet all reasonably expected water supply and water quality control needs;

(3) provide sufficient sites for industrial, commercial, residential, and public purposes responsive to the development plan and provide adequate access and utilities for these sites; (4) provide fishing, hunting and general outdoor recreational opportunities for an expanding population. To estimate the beneficial effects to the nation and to the region of any plan which would meet these objectives; to determine the magnitude of the non-water related costs; and to meet the associated objective of gaining an insight into possible area development, a sketch of developmental plan was prepared for 1,800 acres of land in the Salyersville-Royalton area that could be protected from flooding by a system of water projects. This sketch plan is composed of a land-use plan; a public facilities and utilities plan; and a transportation plan. The sketch plan permits a comparison of site requirements of potential industrial activities against site advantages and an estimate of industrial activities which could advantageously locate in the protected area. Associated service, commercial and residential activities can then be evaluated and potential sites located. The required transportation and urban services can be estimated. This in turn permits an estimate of employment and associated wage and salary flows.

Several plans and combinations of projects were studied for effectiveness in meeting study objectives. Figure 15 shows geographic

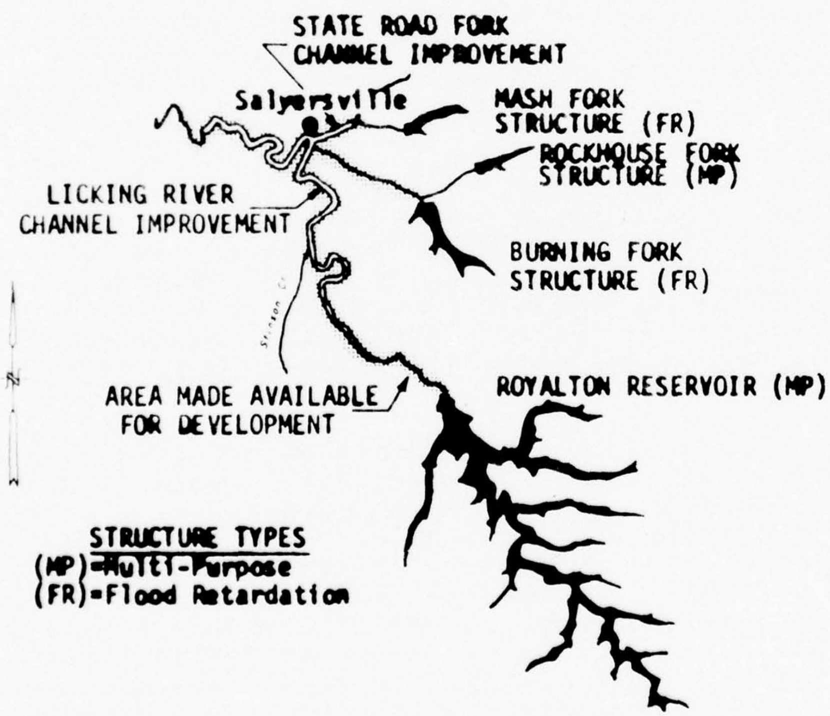


Figure 15. Relative Locations of Selected Water Projects.

relationships of all water projects studied in detail. Essentially single purpose local protection for Salyersville by levee or channel improvement was considered and it was concluded that such a plan would not provide sufficient protected area to permit municipal expansion nor would it provide water flows for additional water supply or water quality control or recreation opportunities. To overcome these deficiencies a multiple-purpose reservoir on the Licking River was evaluated. The reservoir project could not provide an adequate degree of protection along the Licking River beyond Oakley Creek and would not satisfy all of the area's recreational needs. Various systems of single-purpose upstream flood water retarding structures were investigated. Although these systems offer attractive advantages in the tributary areas, they would afford inadequate flood protection to the main stem flood plain in the Licking River. Nonstructural measures, including land treatment and flood plain management, offer much promise as complementary elements but are not an effective means of achieving study objectives because such measures would not provide developable lands. The studies clearly showed that neither a single multipurpose project on Licking River nor a system of small single-purpose structures on Licking River tributaries could singly meet study objectives. The essential problem then was to seek the balance between various single and multiple-purpose reservoirs, channel improvements, and nonstructural alternatives which would meet the objectives at least cost.

Four multiple-purpose plans holding promise for effective area development were selected for evaluation. Plan 1 consisted of a multipurpose reservoir on Licking River near Royalton. This reservoir was selected for investigation since a system of smaller tributary reservoirs could not provide the degree of flood protection necessary on Licking River and since the Soil Conservation Service found that the cost of a tributary reservoir system to provide storage for water quality control and water supply would exceed the multipurpose project costs. In the relevant storage range increases in storage in the Royalton Reservoir do not result in significant increases in costs. Four damsites on Licking River in the vicinity of Royalton were investigated. Of these four sites, the site selected would control the largest drainage area at the least cost and has the most favorable geologic conditions. Due to local inflows a dam at this site could not provide the necessary degree of flood protection in the Licking River flood plain downstream from the vicinity of Oakley Creek. Hydraulic studies indicated that improving 14.7 miles of Licking River channel to a maximum bottom width of 180 feet would provide this protection at Salyersville and other flood plain areas.

The Royalton Reservoir in conjunction with this channel improvement was evaluated as Plan 2. Since level bottom lands are at a premium this 180 foot wide channel conflicts with constraints imposed by the sketch development plan. Plan 2 would provide protection from flooding from the Royalton dam downstream to a point about 6 miles below Salyersville, but would provide almost no protection on Burning Fork and State Road Fork where considerable areas of developable land exist and where protection to older and some recent developments is needed.

The third plan considered consisted of the Royalton Reservoir, a channel improvement on the Licking River, with the same lineal limits as Plan 2 but with a maximum bottom width of 140 feet, three small structures located on Burning Fork, Rockhouse Fork, and Mash Fork, and a channel improvement with a 50 foot bottom width on State Road Fork. Hydraulic studies indicated that with these three tributary flood retarding pools in operation a 140 foot wide channel will provide the same degree of protection on the main stem of Licking River below Burning Fork as the 180 foot wide channel in Plan 2. Also the plan provides the required protection on the Forks. Hydraulic studies confirmed the need for a 50 foot wide channel improvement on the lower 1.18 miles of State Road Fork to provide the necessary protection in this tributary's lower reaches.

The fourth plan considered consisted of the Royalton Reservoir and Soil Conservation Service structures of Plan 3, a smaller sized improved channel on the main stem, a small structure on Stinson Creek, and three small structures in the Oakley Creek sub-basin (see exhibit 1). This plan provided the same main stem protection as Plan 3 but resulted in a cost of about $300,000 more than Plan 3.

Comparisons among these four plans for both costs and ability to meet the constraints imposed by the sketch plan were then made to determine which of the plans was the most efficient. Plans 1, 2 and 4 were eliminated because of reasons previously discussed in this section. Accordingly, Plan 3, including accelerated land treatment, was selected as the best related plan.

The selected plan can be described as possessing five elements. Element one is a multipurpose reservoir on Licking River near Royalton, Kentucky. Element two consists of channel improvement on Licking River and State Road Fork, and aesthetic preservation or beautification of the main stem stream banks from Royalton Reservoir through the downstream channel works. Element three consists of two floodwater retarding structures and one multipurpose structure on tributaries of Licking River upstream from Salyersville, Kentucky. Element four consists of needed flood protection land treatment measures within the watershed. Element five consists of industrial site preparation and improvement of public facilities on lands made flood-free by projects of the first three elements. Pertinent data on all elements of the selected plan are presented below.

ELEMENT ONE - ROYALTON RESERVOIR

Pertinent Data

Location: Licking River, Magoffin County, 12 miles upstream from Salyersville.

Project Function: To support sustained growth in the area by reducing the flood hazard, by providing storage for satisfaction of water supply and pollution control needs and by providing areas suitable for water related general outdoor recreation, and hunting and fishing. Project controls 75.6 square miles of drainage area which

is 54 percent of area above Salyersville; supplies 3.5 cubic feet per second (2.26 million gallons per day) for water supply; provides from 5.3 to 14.3 c.f.s. for maintenance of stream quality.

Reservoir:

Item	Elevation in feet above mean sea level	Pool area in acres	Volume (accumulative) in acre feet	Volume (accumulative) in inches of runoff	Pool length along main stem miles
Minimum pool	920	746	11,400	2.8	9.6
Sediment storage			(4,500)	(1.1)	
Recreation			(6,900)	(1.7)	
Water supply and water quality pool	925	860	15,500	3.8	10.4
Seasonal pool	932	1,080	22,220	5.5	11.2
Flood control pool (spillway crest)	958	2,280	64,500	16.0	14.8
Top of dam	980	-	-	-	-

Dam: Rock fill with impervious earth core; maximum height 100 feet; crest length and width are 1,000 and 30 feet, respectively; side slopes are 1 on 3.

Spillway: Uncontrolled, open cut with concrete sill. Located through saddle in left (west) abutment. Bottom width 150 feet.

Spillway design flood: Peak inflow 102,000 c.f.s.; outflow 35,600. Volume 100,000 acre-feet (24.8 inches of runoff).

Outlet works: Six foot diameter cut and cover conduit in right abutment, capacity 1,150 c.f.s. at elev. 958.

Relocations: 275 families; 12 miles of Kentucky route 7 and 2 miles of Kentucky route 542; 15 miles of secondary roads; various utilities and 7 cemeteries.

Recreation facilities: 2 intensive use areas for general outdoor recreation; 2 fisherman access areas; 130 acres of tailwater fishing and general recreation; one wildlife management area. Annual visitor days from 100,000 initially to 250,000 ultimately.

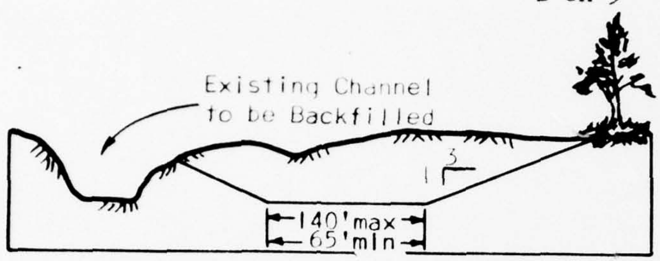
Land requirements: 8,350 acres (fee acquisition), including 1000 acres to be managed as a wildlife unit to mitigate hunting losses and 500 acres of recreation lands specifically for that purpose.

ELEMENT TWO - LICKING RIVER AND STATE
ROAD FORK CHANNEL IMPROVEMENTS
AND AESTHETIC PRESERVATION OF STREAM BANKS

LICKING RIVER CHANNEL IMPROVEMENT

Limits - Licking River mile 279.9 to mile 264.0.

Length	- 14.7 miles
Bottom width (varies)	- 65 to 140 feet
Bankfull capacity (varies)	- 5,300 to 9,800 c.f.s.
Side slopes	- 1 on 3



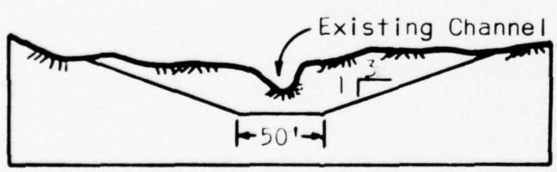
Typical Section - Licking River Channel Improvement

Channel banks along this improvement, and upstream to Royalton Reservoir lands are to be preserved and landscaped for protection and enhancement of the aesthetic values of the existing free-flowing stream.

STATE ROAD FORK CHANNEL IMPROVEMENT

Limits - From the mouth upstream to the confluence of Mash Fork.

Length	- 1.18 miles
Maximum bottom width	- 50 feet
Bankfull capacity	- 3,300 c.f.s.
Side slopes	- 1 on 3



Typical Section - State Road Fork Channel Improvement

STREAM LANDSCAPING

Landscaping and provision of facilities for general recreational purposes and for fishermen along the stream downstream from Royalton Reservoir through Salyersville is included in the comprehensive water resource plan. Estimated first costs of $135,000 are shown in the detailed cost estimate for Licking River Channel Improvement. This landscaping would include clearing and grading necessary to provide hiking trails, bridle paths, and access. Park benches and picnic tables would be provided at various points along the stream banks.

A detailed plan, profile and typical channel sections of the Licking River channel improvement and a detailed plan of the State Road Fork channel improvement are presented in the survey document.

ELEMENT THREE - UPSTREAM STRUCTURES ON TRIBUTARIES

ROCKHOUSE FORK MULTIPLE-PURPOSE STRUCTURE

Pertinent Data

Location: Rockhouse Fork of Burning Fork, a tributary of Licking River, 4.7 stream miles upstream from Salyersville.

Project function: To support sustained growth in the area by reducing the flood hazard on the tributaries and contributing to reductions on the main stem and for recreational purposes. Project controls 4.75 square miles which is 3.4 percent of the area above Salyersville.

Reservoir:

Item	Elevation in feet above mean sea level	Pool area in acres	Volume (accumulative) in acre-feet
Sediment pool	920	21	250
Recreation pool	936	60	710
Flood control pool (spillway crest)	948	106	1,750

Dam: Earth fill, 62 feet high, 700 feet long, top width 15 feet, side slopes are 1 on 3.

Emergency spillway: Through rock abutment.

Principal spillway: Concrete conduit, capacity 180 c.f.s.

Land requirements: 166 acres, of which 60 acres are for recreational facilities and with a capacity for 20,000 annual visitor days.

BURNING FORK FLOODWATER RETARDING STRUCTURE

Location: Burning Fork, a tributary of Licking River, 3.2 stream miles upstream from Salyersville.

Project function: To support sustained growth in the area by reducing the flood hazard on the tributaries and contributing to reductions on the main stem. Project controls 6.66 square miles which is 4.8 percent of the area above Salyersville.

Reservoir:

Item	Elevation in feet above mean sea level	Pool area in acres	Volume (accumulative) in acre-feet
Sediment pool	878	42	355
Flood control pool (spillway crest)	895	114	1,070

Dam: Earth fill, 41 feet high, 1,000 feet long, top width 15 feet, side slopes are 1 on 3.

Emergency spillway: Through rock abutment.

Principal spillway: Concrete conduit, capacity 214 c.f.s.

Land requirements: 114 acres.

MASH FORK FLOODWATER RETARDING STRUCTURE

Location: Mash Fork of State Road Fork, a tributary of Licking River, 1.9 stream miles upstream from Salyersville.

Project function: To support sustained growth in the area by reducing the flood hazard on the tributaries and contributing to reduction on the main stem. Project controls 4.98 square miles which is 3.5 percent of the area above Salyersville.

Reservoir:

Item	Elevation in feet above mean sea level	Pool area in acres	Volume (accumulative) in acre-feet
Sediment pool	880	28	265
Flood control pool (spillway crest)	896	83	785

Dam: Earth fill, 49 feet high, 600 feet long, top width 15 feet, side slopes are 1 on 3.

Emergency spillway: Through rock abutment.

Principal spillway: Concrete conduit, capacity 160 c.f.s.

Land requirements: 83 acres.

ELEMENT FOUR - LAND TREATMENT MEASURES

An accelerated land treatment program to provide protection to the watershed lands, to reduce sediment production, to assure benefits to agricultural flood plain lands, and to protect the structural measures and the development land is included. In addition to going programs, this accelerated program would provide technical and mechanical practices on forest and open lands above the lower limits of the channel improvement (river mile 264.0) and on those flood plain lands along the Licking River to the Cave Run Reservoir on which project benefits have been evaluated.

ELEMENT FIVE - AREA DEVELOPMENT PLAN

This plan is subdivided into three general developmental plans as follows: (1) Land-Use Plan (2) Public Facilities and Utilities Plan and (3) Transportation Plan. Each of these plans provide for the estimated potential or demand for the land uses or facilities considered. An estimate of investment was derived for each element and phased by decade to the year 2020.

Present and projected land requirements are divided into industrial, residential, and commercial land-use needs. These needs have been investigated separately and allocations made to each.

Four general districts were chosen for initial allocation to industrial use. These have been termed the Southern, Eastern, Central, and Northwestern Industrial Districts. Pertinent information concerning each is given in the tabulation on the next page.

The residential development plan establishes 17 areas for residential use and assigns density standards for each area. Twelve of the 17 areas would be used for single family development. These 12 areas have a total land area of approximately 710 acres, which permits an increase of 1,614 one-family dwelling units with a total population holding capacity of 5,646 persons. Five areas totaling 55 acres were set aside for multi-family units. Eight hundred twenty five units having a total holding capacity of 2,065 persons could be constructed on these sites. Total new investment in residential development over a 50-year (1970-2020) period is estimated at $41,900,000.

The commercial land use plan calls for redevelopment of the Salyersville central business district into a semi-mall concept and the commercial development of six other areas. The plan provides

for about 636,000 square feet of building area to be installed by 2020, on a total of 73 acres of land at an estimated cost of $10,800,000.

Substantial increase in public facilities will be needed in the Salyersville-Royalton area. These include schools, a hospital, fire protection facilities, recreation facilities (not water related), sewer and water distribution, and treatment system facilities. Total Federal and non-Federal investments by 2020 in these facilities are estimated at $6,200,000 and $3,700,000, respectively.

The transportation plan consists of 20.63 miles of new and improved highways as shown on page 27 of Appendix A. The plan calls for completion of this highway net by 2010 at a total estimated cost of $5,600,000 of which $2,900,000 would be Federal.

It is estimated that a total investment of about $208,000,000 would be required by 2020 to implement the area improvement plan substantially as outlined herein. This investment would have a substantial impact on strengthening Kentucky Appalachia's economy, and would have many multiplier effects not estimated in this report.

Planned Industrial Districts

Name of District	Number of lots	Size (acres)	Average size of lots (acres)	Average lot frontage (feet)	Lot size range (acres)
Southern Industrial District	25	369	14.8	780	5-30
Eastern Industrial District	13	71	5.5	415	5-11
Central Industrial District	20	193	9.7	560	4-20
Northwestern Industrial District (Reserve)	25	254	10.0	575	5-25
Totals	83	887	-	-	-

8. COMPARISON OF SELECTED PLAN WITH AVAILABLE ALTERNATIVE SOLUTIONS

In designing this project all of the known reasonable alternatives have been considered, including the possibility of taking no development step at this time. To take no step in this case would be to miss the opportunity for utilizing the available and unused or under used labor of this area and would deny this community the full economic advantages of the major public investments recently made in highways, and to a lesser degree in other public facilities. The positive forces making for a favorable climate for development are judged to be present today and suggest that this is the time for action in this community, particularly as the Appalachian Regional Development Act of 1965 envisions early action to solve the depressed condition of the Appalachian economy.

The selection of one large and three small reservoirs was made after considering the possibility that other combinations of reservoirs, with and without channel improvements, might serve the need more economically. It was found that small reservoir sites are not available to do the job that Royalton Reservoir can do. On the other hand the flood control and other water needs cannot be met without the three small reservoirs shown in the plan. The Soil Conservation Service joined the Corps of Engineers in the determinations leading to the reservoir and channel plan presented herein.

The possibilities that levees and floodwalls rather than reservoirs and channel improvements might be used to solve the problem was studied. This approach would be ineffective since most of the valuable bottom land would lie within the floodway and be unsuitable for intensive development. A plan including levees was considered for this area and is described in House Document No. 261, 77th Congress, 1st Session. This plan is not satisfactory to the community since the community would be fragmented and would not be provided an opportunity for growth because of the small amount of undeveloped land that would be protected.

A further alternative considered was the possibility that suitable industrial sites might be developed by filling valley lands above flood heights. The Salyersville community did this successfully for one manufacturing plant, but this method is not practicable for general use, since large scale filling (without flood storage) would restrict the floodway and sharply increase flood hazard on remaining valley lands. Moreover, while it might be an economically feasible means for protecting a few sites against floods it contributes nothing to the fulfillment of other needed water services.

Flood insurance does not seem to be an alternative as a program of flood insurance would cost in excess of the estimated damages with development in place. These damages would greatly exceed the cost of the water control projects.

9. ECONOMIC CHARGES OF SELECTED PLAN

The total cost of construction of the multiple purpose reservoir, multiple purposes structure, two floodwater retarding structures, accelerated land treatment and two channel improvement projects included in the comprehensive water resource plan for the Upper Licking River Basin is estimated to be $43.732.000. Cost estimates for all projects were developed with consideration for local site conditions. The accelerated land treatment program is estimated to be $1,773,000. Future increments of recreation, contingencies, engineering and design, and supervision and administration, are included in the amount given above. Contingency amounts are based on the degree of adequacy of information on which the estimates for specific items are based. Cost of engineering and design, supervision and inspection and overhead charges have been taken from curves on Government cost of civil works projects for reservoirs and local flood protection projects furnished with ORDPD Req. No. 1110-13, 8 March 1966. A summary of the first cost of the six water resource projects is given as a part of Table 1. Detailed cost estimates for Royalton Reservoir and the two channel improvement projects are given in Tables 4, 6, and 8. Summaries of estimated first costs of the Royalton Reservoir are given in Tables 2 and 3 and for the three SCS structures are given in Table 10.

Based on data presented in the cost estimates, annual financial charges were developed for the six water resource projects and annual economic charges were developed for Royalton Reservoir. Annual economic charges for the channel improvement projects are the same as financial charges. For the SCS structures, the amount of lands involved is so small that the difference in financial and economic charges is negligible. A summary in annual charges for the water resource projects is presented in Table 1.

With the exception of Royalton Reservoir the construction costs are equal to the investment costs as the construction period is less than two years. For Royalton Reservoir, the investment cost includes the construction cost plus interest on the initial increment equal to one-half of the four year construction period.

For all projects the current Federal interest rate of 4.875 percent is used and the amortization periods are 100 years. Costs are included as separate items for major replacement of those portions of the reservoirs that are expected to have a physical life less than 100 years. Allowance for loss of land productivity is based on 6 percent annual net income on reservoir lands. Detailed estimates of annual charges are given in Tables 5, 7, 9, and 10.

Table 1. Summary of Estimated First Costs, and Annual Economic Charges for the Selected Plan

	Total First Costs ($)	Annual: Charges-Investment ($)	Annual: Operation, Maintenance & Replacement ($)	Annual: Economic Charges ($)
Water Resource Plan				
Reservoirs: 1/				
Royalton Reservoir	35,647,000 2/	1,913,000	110,000	2,023,000
Rockhouse Fork Structure	1,039,000	51,000	7,000	58,100
Burning Fork Structure	964,000	47,500	500	47,800
Mash Fork Structure	494,000	24,300	500	24,800
Channel Improvements: 1/				
Licking River Channel Improvement 5/	5,230	257,200	3,600	260,800
State Road Fork Channel Improvement	358	17,600	600	18,200
Total - Water Resource Structural Plan	43,732,000	2,310,400	122,300	2,432,700
Accelerated Land Treatment	1,773,000	-- 6/	--	-- 6/
Total - Water Resource Plan	45,505,000	2,310,400	122,300	2,432,700
Area Development Plan				
Investment Cost 1/	256,600,000	4,317,000	-- 3/	4,317,000
Total 4/	302,105,000	6,627,400	122,300	6,749,700

1/ Price levels - July 1969
2/ Includes future increment of recreation
3/ Imputed to charges and benefits of improvement plan
4/ Preauthorization cost of $60,000 not included
5/ Includes allowance for stream landscaping
6/ The Soil Conservation Service considers benefits of these measures to equal their costs, therefore annual costs for these measures were not determined

Table 2. Summary of costs for Royalton Reservoir, Upper Licking River, Kentucky (Report Base)

Item	Cost ($1,000)
Lands and damages	$ 8,800
Relocations	10,600
Reservoir	270
Dam and appurtenances	4,780
Recreation:	
Initial	880
Future increment	420
Total recreation	1,300
Buildings, grounds and utilities	180
Permanent operating equipment	78
Engineering and design	1,810
Supervision and inspection	860
Overhead	442
Total estimated cost 1/	$29,220
Less future recreation increment	
Total estimated initial cost (February 1967)	

1/ Preauthorization cost of $60,000 not included

Table 3. Summary of costs for Royalton Reservoir, Upper Licking River, Kentucky (Current Base)

Item	Cost ($1,000)	Cost with indirect costs distributed ($1,000)
Lands and damages	$10,448	$10,448
Relocations	13,008	15,336
Reservoir	465	548
Dam and appurtenances	5,928	6,989
Recreation:		
Initial	1,090	1,328
Future increment	630	630
Total recreation	1,720	1,958
Building, grounds and utilities	217	256
Permanent operating equipment	95	112
Engineering and design	2,243	
Supervision and inspection	1,523	
Total (July 1969)	$35,647	$35,647

Table 4. Detailed estimate of first cost for Royalton Reservoir, Upper Licking River, Kentucky

Item	Unit	Quantity	Unit Price	Amount
		Lands and damages, Joint-Use Lands		
Fee acquisition				
Homesites	Acre	275	$ 750	$ 206,000
Commercial, school & church sites	Acre	15	1,000	15,000
Cropland	Acre	1,435	300	431,000
Pasture	Acre	1,100	75	82,700
Woodland	Acre	4,700	22	105,000
Wasteland	Acre	325	10	3,300
Subtotal, fee acquisition		7,850		$ 843,000
Improvements	Job	1	-	1,140,000
Isolation	Job	1	-	608,000
Mineral Rights *	Job	1	-	4,620,000
Severance Damages	Job	1	-	297,000
Resettlement Cost	Each	275	500	138,000
Contingencies				759,000
Acquisition Cost	Tracts	475	1,000	475,000
Total, Joint-Use Lands				$8,880,000
		Specific-use lands and damages, recreation		
Fee acquisition				
Lands	Acre	500	$ 30	$ 15,000
Acquisition	Job	1	-	5,000
Total, recreation				$ 20,000
Total Lands and Damages				$8,900,000

* Increased from $1,120,000 in BERH report.

Table 4. (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
	Relocations			
Roads (Summary)				
State roads 7 & 542	Job	1	-	$5,520,000
Secondary roads Magoffin Co.	Job	1	-	2,500,000
Right-of-way	Job	1	-	300,000
Total, roads				$8,320,000

Roads (detailed estimate)

Ky. State Hwy. 7 is class 5 - 40 MPH; Max. 13.5° curves; Max. 8% Grade; 22' Asph. Surf. on 34' Roadbed.
Ky. State Hwy. 542 is class A R.S. - Max. 36° Curves; Max. 12% Grades; 18' Asph. Surf. on 24' Roadbed.
Secondary Roads are class B R.S. - Max. 56° Curves; Max. 14% Grades; 16' TBM Surf. on 20' Roadbed. Unit costs shown below are averages.

State Roads:

Item	Unit	Quantity	Unit Price	Amount
Ky. 7	Mi.	11.8	$350,000	$4,130,000
Gun Ck. Str.	Ea.	1	32,000	32,000
Jake Fk. & Pucheon Br. Str.	Ea.	1	179,000	179,000
Salt Lick Br. Str.	Ea.	1	151,000	151,000
Long Br. Str.	Ea.	1	251,000	251,000
Whitley Br. Str.	Ea.	1	126,000	126,000
Howard Br. Str.	Ea.	1	61,000	61,000
Molly Br. Str.	Ea.	1	10,000	10,000
	Subtotal Ky. 7			$4,940,000
Ky. 542	Mi.	2	186,000	372,000
Licking R. Str.	Ea.	1	141,000	141,000
Bone Ck. Str.	Ea.	1	14,000	14,000
Allen Wiseman Br.	Ea.	1	11,000	11,000
	Subtotal Ky. 542			$ 538,000
Ky. 404	Connection to Ky. 7 to be included in cost for Ky. 7			
Remove 7 bridges	Job	1		42,000
	Total State Roads			$5,520,000

Table 4. (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Secondary Roads				
Magoffin Co.	Mi.	15.0	$155,000	$2,330,000
Equal Fk. Str.	Ea.	1	28,000	28,000
Buck Br. Str.	Ea.	1	30,000	30,000
Trace Fk. Str.	Ea.	1	20,000	20,000
Trace Fk. Str.	Ea.	1	30,000	30,000
Meredith Br. Str.	Ea.	1	50,000	50,000
Remove 6 bridges				12,000
	Total, Secondary Roads			$2,500,000
Rights-of-way	Job	1	-	300,000
	Total Roads			$8,320,000
Utilities				
Gas lines	miles	2	Varies	77,000
Compressor station	Ea.	1	-	10,000
Gas wells	Ea.	24	-	119,000
Power lines	Miles	30	3,930	118,000
Telephone lines	Miles	30	1,870	56,000
Subtotal, Utilities				$ 380,000
Schools				
Swampton School	Job	1	-	50,000
Arnett School	Job	1	-	80,000
Subtotal, Schools				$ 130,000
Cemeteries				
Seven (7) cemeteries	Graves	165	200	33,000
Rights-of-way	Job	1	-	7,000
Subtotal, Cemeteries				$ 40,000
Subtotal, Relocations				$8,870,000
Contingencies				1,730,000
Total, Relocations				$10,600,000

Table 4. (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Reservoir and Pool Preparation				
Clearing wooded areas	Acre	600	$ 200	$ 120,000
Wildlife habitat improvement	Job	1	-	4,000
Removal of fences,bldgs,etc.	Job	1	-	101,000
Contingencies				45,000
Total, Reservoir				$ 270,000
Dam and Appurtenances				
Dam				
Stream diversion	Job	1	-	25,000
Clearing and grubbing	Acre	20	250	5,000
Drilling and grouting	Job	1	-	100,000
Stripping excavation, earth	C.Y.	206,000	.60	124,000
Stripping excavation, rock	C.Y.	36,000	.75	27,000
Excavation, borrow	C.Y.	168,500	.60	101,000
Embankment	C.Y.	940,000	.15	141,000
Filter	C.Y.	31,000	5.00	155,000
Bedding	C.Y.	6,170	6.00	37,000
Riprap	C.Y.	15,500	10.00	155,000
Seeding & fertilizing	Acre	10	400	4,000
Trash boom	Job	1	-	10,000
Access roads	Job	1	-	356,000
Subtotal, Dam				$1,240,000
Spillway				
Clearing and grubbing	Job	1	-	1,000
Excavation, earth	C.Y.	42,600	.59	25,000
Excavation, rock	C.Y.	493,900	1.75	864,000
Concrete sill	Job	1	-	20,000
Sill bedding	Job	1	-	1,000
Fertilizer and seeding	Job	1	-	1,000
Guard fence	L.F.	2,000	4.00	8,000
Subtotal, Spillway				$ 920,000

Table 4.(Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Outlet Works				
Clearing and grubbing	Job	1	$ -	$ 1,000
Excavation, struct. earth	C.Y.	4,000	2.00	8,000
Excavation, struct. rock	C.Y.	14,000	6.00	84,000
Excavation, channel earth	C.Y.	20,000	0.75	15,000
Excavation, channel rock	C.Y.	12,000	2.50	30,000
Backfill	C.Y.	28,800	2.50	72,000
Concrete, stilling basin & wings	C.Y.	1,500	45	68,000
Reinf. steel, stilling basin & wings	Lbs.	90,000	0.15	14,000
Concrete conduit (6' circular)	L.F.	450	Varies	120,000
Cement, stilling basin & wings	Bbl.	3,000	6.00	18,000
Operating tower	Job	1	-	360,000
Service bridge & appurt.	Job	1	-	105,000
Gates, operating equip., heating and plumbing	Job	1	-	293,000
Electrical work	Job	1	-	25,000
Riprap	C.Y.	592	10.00	6,000
Guard fence, stilling basin	Job	1	-	1,000
Subtotal, Outlet Works				$1,220,000
Beautification				25,000
Total, spillway, dam, outlet works and beautification				$3,405,000
Contingencies *				1,375,000
Total, Dam and Appurtenances				$4,780,000

* Increased from $655,000 in BERH report to allow for foundation excavation treatment ($520,000) and increased capacity of outlet works ($200,000).

Table 4.(Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Recreation				
Initial Facilities				
Picnic units	Ea.	67	$ 150.	$10,000
Camping units	Ea.	100	500.	50,000
Parking	S.Y.	7,000	5	35,000
Roads	Mile	3	60,000	180,000
Launching Ramps	Ln	8	5,000	40,000
Water supply	Gal.	30,000	2	60,000
Sanitation	Job	1	L.S.	250,000
Beach-change house	Job	1	L.S.	50,000
Walks	Mile	0.5	16,000	8,000
Trails	Mile	2.0	5,000	10,000
Playground equipment and site improvement	Job	1	L.S.	75,000
Subtotal Initial Facilities				$768,000
Contingencies				112,000
Total, Initial Facilities				$880,000
Future Facilities				
Picnic units	Ea.	100	150	$ 15,000
Camping units	Ea.	150	500	75,000
Parking	S.Y.	4,000	5	20,000
Roads	Mile	0.5	60,000	30,000
Water supply	Gal.	25,000	2	50,000
Sanitation	Job	1	L.S.	100,000
Beach-change house	Job		L.S.	25,000
Playground equipment and site improvement	Job		L.S.	50,000
Subtotal Future Facilities				$365,000
Contingencies				55,000
Total, Future Facilities				420,000
Total, Recreation				$1,300,000

Table 4. (Cont'd)

Item	Unit	Quantity	Unit Price	Amount
Buildings, Grounds and Utilities				
Shop building	Ea.	1	$20,000	$ 20,000
Site development and utilities for shop building	Job	1	-	10,000
Operators' quarters	Ea.	2	20,000	40,000
Site development and utilities for quarters	Job	1	-	15,000
Utilities for dam structures	Job	1	-	15,000
Visitor Overlook-Info.Center	Job	1	-	50,000
Subtotal, Buildings, Grounds and Utilities				150,000
Contingencies				30,000
Total, Buildings, Grounds and Utilities				$ 180,000
Permanent Operating Equipment				
Tractor, mower, tools, boats, etc.	Job	1	-	$ 20,000
Radio facilities	Job	1	-	15,000
Rainfall and discharge stations	Job	1	-	30,000
Subtotal, permanent operating equipment				$ 65,000
Contingencies				13,000
Total, Permanent Operating Equipment				$ 78,000

Table 5. Detailed estimate of annual charges for Royalton Reservoir, Upper Licking River, Kentucky

Item	Financial ($1,000)	Economic ($1,000)
a. Total investment- Initial Project		
(1) Recapitulation of project costs		
(a) Total net costs	35,017	35,017
(b) Market value of lands - Amount is inclusive in total (1) (a) above		1,007
(2) Interest during construction 4-7/8% for 1/2 construction period, 4 years (9.75%)	3,414	3,414
(3) Total gross investment	38,431	38,431
(4) Net salvage value (.80x1,007)		806
(5) Total Federal net investment	38,431	37,625
b. Annual Charges		
(1) Interest on gross investment		
(a) Financial: (.04875)(38,431,000)	1,874	
(b) Economic: (.04875)(38,431,000)		1,874
(c) Economic: Adjustment for net loss of land (.06-.04875)(1,007,000)	-	11
(2) Amortization on net investment		
(a) Financial: (.00042)(38,431,000)	16	
(b) Economic: (.00042)(37,625,000)		16
(3) Maintenance and operation		
(a) Dam and reservoir	50	50
(b) General recreation	20	20
(c) Fish and wildlife recreation	3	3
(d) Fish and wildlife mitigation	4	4

Table 5. (Cont'd)

Item	Financial ($1,000)	Economic ($1,000)
Initial Project		
(4) Major replacements		
(a) Dam and reservoir	10	10
(b) General recreation and fish and wildlife recreation	9	9
(5) Total initial annual charges	1,986	1,997
c. Future Recreation Increment		
(1) Interest on gross investment		
(a) Financial: (.04875)(630,000)(.39994)	12	
(b) Economic: (.04875)(630,000)(.39994)		12
(2) Amortization		
(a) Financial: (.00042)(630,000)(.39994)		
(b) Economic: (.00042)(630,000)(.39994)		
(3) Maintenance and operation		
(a) Dam and reservoir	-	-
(b) General recreation	12	12
(4) Major replacement		
(a) Dam and reservoir	-	-
(b) General recreation	2	2
(5) Total Future recreation increment	26	26
Total Annual Charges	2,012	2,023

Table 6. Detailed estimate of first cost for Licking River Channel Improvement Upper Licking River, Kentucky

Item	Unit	Quantity	Unit Price	Amount
Federal Costs				
Clearing & Grubbing	Job	1	$ L.S.	$ 18,000
Excavation (Earth)	C.Y.	1,549,000	0.30	464,700
Excavation (unclassified)	C.Y.	1,880,000	1.05	1,974,000
Riprap	C.Y.	7,400	10.00	74,000
Seeding and Fertilizing	Acre	140	400.00	56,000
Stream Landscaping	Job	1	L.S.	135,000
Contingencies (20%)				544,300
Subtotal, Construction Cost				$3,266,000
Engineering and design				262,000
Supervision and inspection				130,000
Overhead				82,000
Total Federal First Cost (Report Base)				$3,740,000
Total Federal First Cost (Current Base)				$4,696,000
Non-Federal Costs				
Land and Damages	Job	1	L.S.	68,000
Utility alterations	Job	1	L.S.	10,000
Bridge replacement	Job	1	L.S.	310,000
Contingencies (20%)				73,000
Subtotal				$ 46[illegible],000
Supervision and administration				9,000
Total Non-Federal Cost (Report Base) 1/				$ 470,000
Total Non-Federal Cost (Current Base) 2/				$ 584,000
Total Estimated Costs (Report Base)				$4,210,000
Total Estimated Costs (Current Base)				$5,230,000

1/ February 1967 price level
2/ July 1967 price level

Table 7. Detailed estimate of annual charges for Licking River Channel Improvement Upper Licking River, Kentucky

Federal	Annual charges 1/
Interest @ 4-7/8%	$226,500
Amortization - 100 yrs. @ 4-7/8% (.00042)	2,000
Total Annual Federal Charges	$228,500
Non-Federal	
Interest @ 4-7/8%	28,500
Amortization - 100 yrs. @ 4-7.8% (.00042)	200
Maintenance and Operation	3,600
Total Annual Non-Federal Charges	$ 32,300
Total Annual Charges	$260,800

1/ Financial and Economic

Table 8. Detailed estimate of first cost for State Road Fork Channel Improvement Upper Licking River, Kentucky

Item	Unit	Quantity	Unit Price	Amount
Federal Costs				
Clearing and Grubbing	1	Job	$ -	$ 3,000
Excavation (unclassified)	131,400	C.Y.	1.20	157,680
Riprap	2,590	C.Y.	10.00	25,900
Seeding and Fertilizing	1	Job		2,000
Contingencies				34,420
Subtotal, Construction Cost				$223,000
Engineering and design				28,000
Supervision and inspection				9,000
Overhead				5,000
Total Federal Cost (Report Base)				$265,000
Total Federal Cost (Current Base)				$327,000
Non-Federal Costs				
Land and Damages				$ 5,000
Utility alterations				5,000
Bridge alteration				10,000
Contingencies				4,000
Subtotal				$ 24,000
Supervision and administration				1,000
Total Non-Federal Cost (Report Base)				$ 25,000
Total Non-Federal Cost (Current Base)				$ 31,000
Total Cost (Report Base)				$290,000
Total Cost (Current Base)				$358,000

Table 9. Detailed estimate of annual charges for State Road Fork Channel Improvement Upper Licking River, Kentucky

Federal	Annual Charges 1/
Interest @ 4-7/8%	$15,900
Amortization - 100 yrs. @ 4-7/8% (.00042)	200
Total Annual Federal Charges	$16,100
Non-Federal	
Interest @ 4-7/8%	1,500
Amortization - 100 yrs. @ 4-7/8% (.00042)	20
Maintenance and Operation	580
Total Annual Non-Federal Charges	$ 2,100
Total Annual Charges	$18,200

1/ Financial and Economic

Table 10. Summary of estimated first costs and annual charges for structures Upper Licking River tributaries, USDA Soil Conservation Service

Item	Rockhouse MP Structure		Burning Fork FR Structure		Mash Fork RF Structure	
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal
Estimated First Costs						
Construction	$329,600	$ 59,700	$172,500		$163,500	
Installation Services	96,700		55,500		53,900	
Land	35,600	35,700		$229,000		$101,800
Relocations	52,500	52,500		330,000		85,000
Contract Administration	1,500	200	2,000		800	
Minimum Basic Facilities	93,500	93,500				
Total (Report Base)	$609,400	$241,600	$230,000	$559,000	$218,000	$186,800
Total (Current Base)	$747,000	$292,000	$288,000	$676,000	$268,000	$226,000
Estimated Annual Charges 1/						
Interest (.04875)	36,400	14,200	14,000	33,000	13,100	11,000
Amortization (.00042)	300	100	100	200	100	100
Operation & Maintenance		7,100		500		500
Total	$ 36,700	$ 21,400	$ 14,100	$ 33,800	$ 13,200	$ 11,600
Total Annual Charges (rounded)	$58,100		$47,000		$24,800	
Total First Costs (Report Base)	$851,000		$789,000		$405,000	
Total First Costs (Current Base)	$1,039,000		$964,000		$494,000	

1/ Financial and Economic

Investment costs are based on data presented in Appendix A.* Projected expenditures for 10 year intervals were made for the developmental plan from 1970 thru 2020, at which time the plan is expected to be completed. These projections were made for both Federal and non-Federal investments. All investments were assumed to be uniform during each year of the 10 year intervals. Federal investments were classified entirely as public, with an estimated useful life of 50 years. Non-Federal investments were broken down into the following categories: residential, public, industrial and commercial. Residential and public are assumed to have useful lives of 50 years. Industrial and commercial are assumed to consist of 50 percent equipment, with a 25 year useful life, the remainder having a 50 year life. Major replacements were phased in for both Federal and non-Federal investments in accord with these assumptions for the 100 year project life. All yearly investments were converted to present worth values by use of a 4-7/8 percent interest and amortization table. The accumulated present worth of Federal and non-Federal investments were then spread over the project life at 4-7/8 percent and 5 percent interest rates, respectively. Expenditures for development were separated into four general areas as follows: (1) Upper Licking - above Burning Fork, (2) Burning Fork, (3) State Road Fork, and (4) Lower Licking - below Burning Fork. A summary of this investment cost and annual charges by areas is presented in Table 11.

* Of previously referenced Interim Survey Report of the Upper Licking River Basin.

Table 11. Area development plan investment costs and annual charges ($1,000) Upper Licking River, Kentucky

Area	Federal	Non-Federal	Total
	Total Initial Investment (1970-2020)		
Upper Licking	5,690	98,580	104,270
Burning Fork	1,130	15,270	16,400
State Road Fork	180	2,350	2,530
Lower Licking	2,000	82,400	84,400
Total (Report Base) 1/	9,000	198,600	207,600
Total (Current Base) 2/	11,100	245,500	256,000
	Present work of investment, including major replacement		
Upper Licking	3,940	63,100	67,040
Burning Fork	940	12,100	13,040
State Road Fork	170	2,000	2,170
Lower Licking	1,330	39,700	41,030
Total (Report Base)(3-1/8%)	6,380	116,900	123,280
Total (Current Base)(4-7/8%)	4,469	68,099	72,568
	Annual charges		
Upper Licking	130	3,180	3,310
Burning Fork	30	610	640
State Road Fork	6	100	106
Lower Licking	44	2,000	2,044
Total (Report Base)(3-1/8%)	210	5,890	6,100
Total (Current Base)(4-7/8%)	219	4,098	4,317

1/ February 1967 price level
2/ July 1967 price level

10. ECONOMIC BENEFITS ATTRIBUTABLE TO THE SELECTED PLAN

A description of the procedures and techniques used to measure benefits creditable to the selected plan and pertinent benefit defitions is given in Appendix C of the survey document.

Benefits which would flow to the Nation and to the project region from the proposed comprehensive plan can be classified into two broad categories, user and expansion benefits. These classifications can be divided into tangible and intangible categories to differentiate between those benefits to which monetary values can and cannot be assigned. Tangible user benefits are the values of goods and services directly provided by the project, such as flood damage prevention or reduction. Tangible expansion benefits are the values of the increases in wages and profits stemming from project construction and employment in project goods and services in combination with other resources. Intangible benefits include the diminishing of hazards to life and threats to public health and safety, and improvement in the amenities and aesthetics of life in the project area.

User benefits attributable to the water control projects in the selected plan are divided among the following general classifications: Flood control, land enhancement, general and fish and wildlife recreation enhancement, water supply and water quality. With minor exception these benefits will contribute equally to improvement in the economic well-being of the Nation and the immediate project area.

Expansion benefits are presented in two components. One, described as redevelopment benefits, is measured in terms of the wage and salary components of expenditures for construction and operation and maintenance of the water control projects. The increment of wages and salaries accruing to persons who otherwise would be unemployed or underemployed is creditable to both the national and regional accounts; the remainder, only to the regional account.

The second component of expansion benefits, identified as development benefits, is measured in terms of wage and salary and other income flows generated by the area development plan. These benefits attributable to both water project and associated investments are creditable in varying degree to the national and regional economic accounts.

Determination of the portion of expansion benefits assignable to the national economic account in recognition of net gains and national economic performance is difficult. A methodology suitable for application in all areas and situations, both within and beyond Appalachia, remains to be developed. Research on this problem is continuing. In making an approximation for the selected plan, recognition was given to the limited number of attractive sites favorable to economic development and to the reasonably favorable balance of industry locational characteristics other than attractive sites. Another consideration was

the probability that a substantial level of regional resources would, for a considerable time, remain unemployed or underemployed in the absence of the selected plan, regardless of other favorable forces which may be at work now or later within and beyond the study area. Given the level of development projected in the sketch plan described previously, potential wages and salaries of the selected plan are shown on Figure 16.

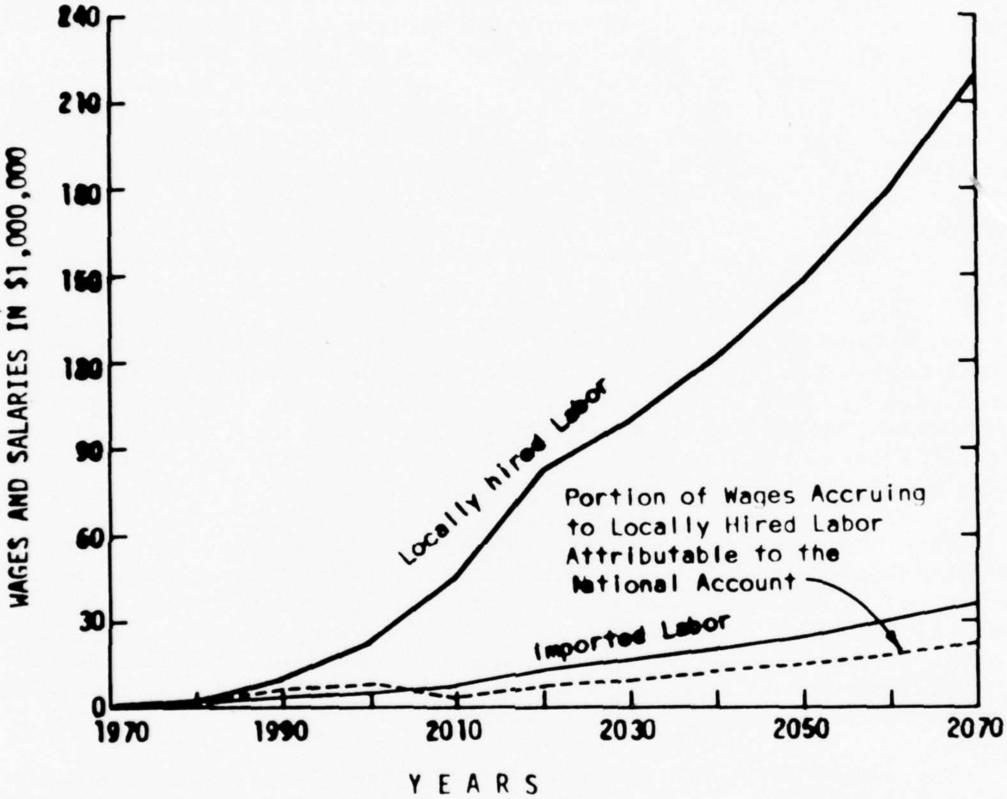


Figure 16. Wages and Salaries Generated by the Plan.

The local hires would normally be expected to be obtained from the ranks of unemployed or underemployed to the extent of the available supply. Those wages and salaries accruing to the unemployed or underemployed are normally credited to both the national and regional accounts as a measure of increased national productivity. However, in consideration of the forces presently at work to reduce unemployment and other programs which will probably be directed to that end

in the future, the wages and salaries accruing to the national benefit account have been reduced in accordance with the following Figure 17.

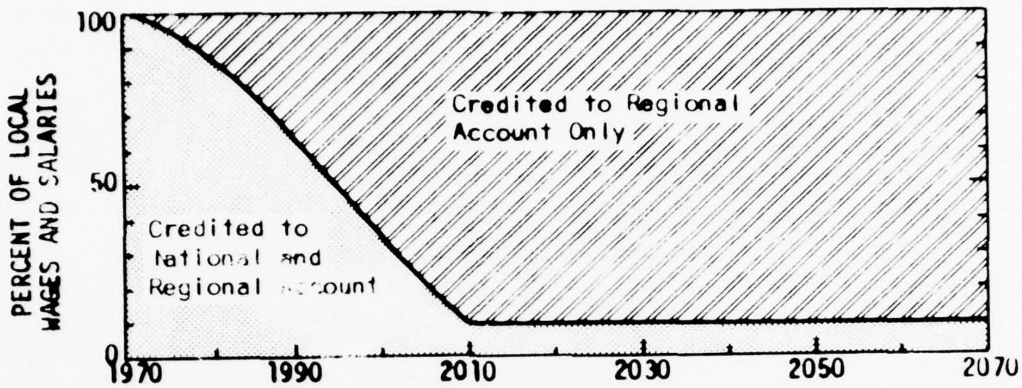


Figure 17. Local Wage and Salary Adjustment Curve for National Account.

A precise analytical procedure for making the kind of adjustment shown in Figure 17 is not now available and the division between national and regional accounts must be recognized as being somewhat arbitrary and illustrative in nature.

In addition to salaries and wages credited as described above, the regional economic accounts are credited with a return on investment factor computed annually as ten percent of the industrial and commercial investment in effect in each year of operation of the selected plan, discounted to 1970 at 4-7/8 percent interest rate. Replacement investments necessitated by normal wear or obsolescence are not used in this determination. This assignment of benefits reflects the conditions described above with respect to site availability, industry locational characteristics and probable residual unemployment and underemployment. If it were possible to determine precisely the full range of alternative commercial and industrial investment opportunities which would be available in the absence of the selected plan, it is probable that some discounting would be appropriate. Computations of this kind, however, must await development of more sophisticated evaluation procedures and further definition of the overall Appalachian program.

With respect to intangible benefits, it should be noted that the Salyersville-Royalton area has experienced flooding characterized by sudden and rapid rises with swift currents. On many flood occasions, loss of life has been narrowly averted. Due to flood characteristics and location of most roads on the flood plain, large segments of the

population are isolated from emergency assistance during floods. Others are compelled to seek temporary housing in community and relief shelters with substandard or inadequate health and sanitation facilities. Areas subject to frequent flooding are difficult to maintain in a pleasing aesthetic condition. Heavy and frequent flood damages create a demoralizing effect on self-help efforts for community improvements and new investment. The plan will clearly produce many intangible benefits by abating these effects.

A summary of monetary benefits accruing to the comprehensive development plan is presented in Table 12.

Table 12. Summary of benefits for the selected plan of development

Category and class of benefits	Annual benefit ($1,000) National account only	Regional account only	National and regional account	Total national account	Total regional account
User benefits					
Flood control	-	-	411	411	411
Land enhancement	-	-	159	159	159
Water quality control	-	-	52	52	52
Water supply	-	-	30	30	30
Recreation	84	-	156	240	156
Total user benefits	84	-	808	892	808
Expansion benefits					
Redevelopment	-	229	171	171	400
Development - wages	-	26,105	5,845	5,845	31,950
Total expansion benefits	-	26,334	6,016	6,016	32,350

11. ALLOCATED AND APPORTIONED COSTS

Cost allocations were performed to divide costs between purposes, including multiple-purpose projects. The essential purpose of cost allocation is to provide an equitable basis for apportioning costs. The Separable Costs - Remaining Benefits method was utilized for the Royalton Reservoir, while a use-of-facilities method was utilized for the Rockhouse Fork Structure. Both methods meet the equity test and each method is utilized where most appropriate. Other elements of the Comprehensive Plan are essentially single-purpose and require no allocations.

The Separable Costs - Remaining Benefits method was utilized for the Royalton Reservoir with regional income expansion as an explicit purpose. Thus, a share of joint project costs are allocated to regional income expansion. Total project costs were utilized as the relevant limit on benefits, in the absence of a fully-refined array of alternative means for attaining similar levels of regional income. Since the case for the recommended plan being the best solution, at least in terms of alleviating water related growth constraints, this assumption is believed to be adequate for cost allocation purposes. A summary of cost allocations for Royalton Reservoir is presented in Table 13, while the summary of costs and allocation of costs are presented in Tables 14 and 15, respectively.

Table 13. Summary of allocated construction costs and annual O, M & R charges ($1,000), Royalton Reservoir, Kentucky

Item	Allocated ($1,000) Construction Costs	Allocated ($1,000) OM and R Charges (Annual)
Flood Control	4,447	21
Water Quality	816	1
Water Supply	481	0
Recreation	2,699	50
Regional Income Expansion	27,204	38
Total	35,647	110

TABLE 14

Summary of Costs ($1,000)
Elements One and Five
Royalton Reservoir - Salyersville Area Plan

Item	Multiple Purpose Plan: Specific Use Lands and Facilities: Flood Control	Water Quality	Water Supply	Recre- ation	Regional Income Expansion	Joint Use Lands & Facil.	Total Costs	Single Purpose Projects: Flood Control	Water Qualtiy	Water Supply	Recre- ation	Multiple Purpose Projects Less: Flood Control	Water Quality	Water Supply	Recre- ation	Regional Income Expansion
Construction First Costs																
Element One (Royalton Reservoir)																
Lands and Damages				24		10,424	10,448					24	10,448	10,448		10,448
Relocations						15,336	15,336					30,093	15,336	15,336		15,336
Reservoir & Pool Preparation						548	548						548	548		548
Dam and Appurtenances						6,369	6,369						6,369	6,369		6,369
Access Roads						620	620						620	620		620
Recreation Facilities				1,321		-	1,321					1,321	1,321	1,321		1,321
Fish and Wildlife				7		-	7					7	7	7		7
Buildings, Grounds & Utilities						256	256						256	256		256
Permanent Operating Equipment						112	112						112	112		112
Total Initial				1,352		33,665	35,017	32,576	911	519		31,445	35,017	35,017	33,463	35,017
Future Recreation Facilities				630		-	630	-	-	-		630	630	630	-	630
Total Element One				1,982		33,665	35,647	32,576	911	519		32,075	35,647	35,647	33,463	35,647
Element Five (Development Plan)				-	256,600	-	256,600	-	-	-		256,600	256,600	256,600	256,600	-
Total Construction Costs				1,982	256,600	33,665	292,247	32,576	911	519		288,675	292,247	292,247	290,063	35,647
Investment Costs																
Element One																
Initial Construction Costs				1,352		33,665	35,017	32,576	911	519		31,445	35,017	35,017	33,463	35,017
Interest During Construction (.0975)				132		3,282	3,414	3,176	-	-		3,066	3,414	3,414	3,263	3,414
Investment Costs, Initial Increment				1,484		36,947	38,431	35,752	911	519		34,511	38,431	38,431	36,726	38,431
Future Recreation Facilities				630			630	-	-	-		630	630	630	-	630
Element Five				-	256,600	-	256,600	-	-	-		256,600	256,600	256,600	256,600	-
Total Investment Costs				2,114	256,600	36,947	295,661	35,752	911	519		291,741	295,661	295,661	293,326	39,061
Annual Financial Charges																
Initial Increment																
Interest and Amortization (.04917)				73		1,817	6,207	1,758	45	26		6,014	6,207	6,207	6,123	1,890
Operation and Maintenance																
Dam				-		50	50	50	7	4		30	50	50	50	50
Recreation				27		-	27	-	-	-		27	27	27	-	27
Major Replacement																
Dam				-		10	10	5	-	-		10	10	10	10	10
Recreation				9		-	9	-	-	-		9	9	9	-	9
Total Initial Increment				109	4,317	1,877	6,303	1,813	52	30		6,090	6,303	6,303	6,183	1,986
Future Increment (Discounted)																
Interest and Amortization				12		-	12	-	-	-		12	12	12	-	12
Operation and Maintenance				12		-	12	-	-	-		12	12	12	-	12
Major Replacement				2		-	2	-	-	-		2	2	2	-	2
Total Future Increment				26		-	26	-	-	-		26	26	26	-	26
Total Annual Financial Charges				135	4,317	1,877	6,329	1,813	52	30	178	6,116	6,329	6,329	6,183	2,012

TABLE 15 - ALLOCATION OF COSTS ($1,000)
SEPARABLE COSTS - REMAINING BENEFITS METHOD
ELEMENTS ONE & FIVE
ROYALTON RESERVOIR - SALYERSVILLE AREA PLAN

	ITEM	FLOOD CONTROL	WATER QUALITY	WATER SUPPLY	RECRE-ATION	REGIONAL EXPANSION EFFECTS	TOTAL
1	Benefits	277	52	30	210	32,350	32,919
2	Alternative Costs	1,813	52	30	178	6,329	8,402
3	Benefit Limits	277	52	30	178	6,329	6,866
4	Separable Costs	213	0	0	146	4,317	4,676
5	Remaining Benefits	64	52	30	32	2,012	2,190
6	Allocation of re-tricted joint costs						
a.	Remaining Benefits	--	52	30	32	--	114
b.	Ratio	--	.4561	.2632	.2807	--	1.0000
c.	Allocated re-stricted costs1/	--	24	14	15		53
7	Separable plus allocated re-stricted costs	213	24	14	161	4,317	4,729
8	Remaining Benefits	64	28	16	17	2,012	2,137
9	Ratio	.0299	.0131	.0075	.0080	.9415	1.0000
10	Allocated joint costs	48	21	12	13	1506	1600
11	Total allocated financial costs	261	45	26	174	5823	6,329
	ALLOCATION OF OPERATION, MAINTENANCE, AND REPLACEMENTS COSTS						
12	Separable O,M&R charges	20	0	0	50	0	70
13	Allocated joint O,M&R	1	1	0	0	38	40
14	Total allocated O,M&R	21	1	0	50	38	110

TABLE 15 (cont'd)

	ITEM	FLOOD CONTROL	WATER QUALITY	WATER SUPPLY	RECRE-ATION	REGIONAL EXPANSION EFFECTS	TOTAL
	ALLOCATION OF INVESTMENT COSTS						
15	Annual Investment Costs	240	44	26	124	5785	6219
16	Capitalized Investment Costs 1 ÷ .04917 = 20.3376042	4881	895	528	2522	286,456 2/	295,282
17	Adjustment for discount on future increment	--	--	--	379	--	379
18	Total allocated investment costs	4881	895	528	2901	286,456	295,661
	ALLOCATION OF CONSTRUCTION COSTS						
19	Investment in specific - use lands and facilities	--	--	--	2114	256,600	258,714
20	Investment in joint - use lands and facilities	4881	895	528	787	29,856	36,947
21	Interest on joint-use lands and facilities	434	79	47	70	2652	3282
22	Allocated construction cost of joint use lands and facilities	4447	816	481	717	27,204	33,665
23	Construction cost of specific use lands and facilities	--	--	--	1982	256,600	258,582
24	Total allocated construction costs	4447	816	481	2699	283,804	292,247
25	Construction cost of future increment	--	--	--	630	--	630
26	Construction cost of element five	--	--	--	--	256,600	256,600
27	Construction cost of element one (initial)	4447	816	481	2069	27,204	35,017

TABLE 15 (cont'd)

	ITEM	FLOOD CONTROL	WATER QUALITY	WATER SUPPLY	RECRE-ATION	REGIONAL EXPANSION EFFECTS	TOTAL
28	Total construction cost of element one	4447	816	481	2699	27,204	35,647

1/ Cost of MPP (Elements 1 & 5) = $6,329

Cost of MPP (Elements 1 & 5) =	$6,329
Cost of FC Only	6,130
Cost of adding WQ,WS, & Rec.	199
Less assigned separable costs	146
Restricted joint costs	53

2/ (5785 - 4317) = 1468

$1468 \times \frac{1}{.04917} = 29{,}856 + 256{,}600 = 286{,}456$

Cost allocations for the Rockhouse Fork Structure were made by the use-of-facilities method to maintain consistency with practices of the Soil Conservation Service. The method is equitable and consistent when there is not joint use of storage by two or more purposes. A summary of cost allocation for the Rockhouse Fork Structure is presented below in Table 16.

Table 16. Summary of allocated construction costs, Rockhouse Fork Multiple-Purpose Structure, Kentucky

Item	Allocated Construction Costs
	($1,000)
Flood Control	412
Recreation	398
Total	810

Apportionment of costs for the Royalton Reservoir between Federal and non-Federal interests is made according to the following criteria and summarized in Table 17.

a. All costs allocated to flood control in the multiple-purpose project are apportioned to the Federal Government according to applicable flood control legislation. The effects of the project are widespread in the sense of economic impact over the six county study area.

b. All costs allocated for Water Quality Control are apportioned to the Federal Government according to the Water Pollution Control Act of 1961 (PL 87-88). Widespread benefits accrue to the project because of the economic impact of the project services in surrounding counties.

c. All costs allocated to Water Supply are apportioned to non-Federal interests according to the Water Supply Act of 1958 (PL 85-500).

d. The separable first costs associated with recreation development in the reservoir are divided between Federal and non-Federal interests on a 50-50 basis. Non-Federal interests are apportioned all separable operation and maintenance costs associated with this feature. This is in accordance with the Federal Water Projects Recreation Act (PL 89-72).

Table 17. Apportionment of Costs Between Federal and Non-Federal Interests Recommended Water Plan, Upper Licking River Basin, Kentucky

Item	Construction Costs ($1000) Federal	Non-Federal	Total	Annual Operation, Maintenance and Replacement Charges ($1000) Federal	Non-Federal	Total
Royalton Reservoir						
Flood control	4,447	-	4,447	21	-	21
Water quality	816	-	816	1	-	1
Water supply	-	481	481	-	-	-
Recreation	1,607	1,092	2,699	0	50	50
Regional expansion	27,204	-	27,204	38	-	38
Subtotal	34,074	1,573	35,647	60	50	110
Channel Improvement	4,983	605	5,588	-	4.2	4.2
S.C.S. Structure						
Flood control	968.5	901.8	1,870.3	-	2.1	2.1
Recreation	334.5	292.2	626.7	-	6.0	6.0
Subtotal	1,303.0	1,194.0	2,497.0	-	3.1	8.1
Accelerated Land Treatment	1,440	333	1,773	-	-	-
Total Recommended Water Plan	41,800	3,705	45,505	60	62.3	122.3

e. The costs allocated to regional income expansion have been apportioned to the Federal Government in consonance with the Appalachia Regional Development Act of 1965 (PL 89-4).

Apportionment of costs for the channel improvement on Licking River and State Road Fork are based on applicable Flood Control legislation. Non-Federal interests are apportioned the costs of lands, easements and rights-of-way and all operation and maintenance costs.

Apportionment of costs for the Rockhouse Fork, Burning Fork, and Mash Fork structures between Federal and non-Federal interests is made according to the following criteria:

a. All construction, installation services and contract administration costs allocated to flood control are apportioned to the Federal Government.

b. All land, easements and rights-of-way costs allocated to flood control are apportioned to non-Federal interests.

c. All separable installation costs allocated to recreation development will be divided between Federal and non-Federal interests on a 50-50 basis.

d. All operation and maintenance costs are apportioned to non-Federal interests.

Apportionment of costs for the accelerated land treatment program between Federal and non-Federal interests is made according to the following criteria:

a. All technical assistance costs are apportioned to the Federal Government.

b. All costs of installing land treatment measures will be shared on an 80-20 basis between the Federal Government and the landowner.

A summary of the apportionment of costs between Federal and non-Federal interests is presented in table 17.

12. COORDINATION WITH OTHER AGENCIES

Contact with interested Federal and non-Federal agencies was established early in this investigation and has been maintained throughout. Reports and comments received from these agencies are summarized in the following paragraphs.

The Bureau of Outdoor Recreation, Department of the Interior, early in the investigation prior to final formulation of project plans, made a study of the present and projected demand, supply, and needs for non-urban outdoor recreation in the market area of the considered Royalton Reservoir. They estimated that the annual recreation need in the market area will be 6.27 million recreation days by 1980 and 24.78 million recreation days by 2020. The Bureau investigated two plans of development. Plan One would be entirely Federal and only facilities necessary to the general health and safety of the visitors would be provided. This plan would ultimately provide for 20,000 recreation days per year with an annual benefit of $10,000. Plan Two provides for cost sharing in accordance with Public Law 89-72 and more complete facilities would be provided. This plan would ultimately accommodate 174,000 visitor days annually, from which average annual benefits of $113,000 are expected. The Bureau of Ourdoor Recreation concluded that:

(1) There is an unsatisfied demand for outdoor recreation in the project recreation market area.

(2) Although not mentioned therein, this project does not appear to be inconsistent with the Kentucky Comprehensive Outdoor Recreation Plan.

(3) The recreation lands needed to implement development Plan 2 should be acquired in the event a non-Federal interest should decide to cost share in the future.

(4) Only a preliminary analysis of the recreational aspects of this project had been performed. Re-evaluation may be necessary when additonal projects in Appalachia are presented for analysis.

Changes in project concept and physical characteristics made subsequent to the submittal of the report by the Bureau of Outdoor Recreation have resulted in an increased capacity for recreation which would be afforded by the Royalton Reservoir project. These changes include proposed acquisition of 130 acres of lands below the dam for project construction and recreational development, highway relocations which will provide better access to recreational facilities and increased land acquisition for project operation. This increased capacity indicates that a modified Plan Two would ultimately accommodate 250,000 visitor days annually, from which average annual benefits

of $210,000 are expected. Land requirements for this recreation development would be about 500 acres. Past experience in reservoir use indicates that a recongition of this increased capacity would be a desirable measure toward alleviation of overcrowding, overuse and accompanying ill effects that occur when insufficient facility capacity is provided initially.

Under purview of the Federal Water Project Recreation Act the scope of recreational development which may be undertaken is dependent upon receipt of a local expression of intent prior to authorization. Such an expression has been received from the Kentucky Department of Natural Resources. Consequently, modified Plan Two is appropriate, and the cost of full development is included in the estimated cost of the comprehensive development plan.

The Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service, Department of the Interior, has prepared a report on effects the development plan would have on fish and wildlife resources in the upper Licking River basin. Their report gives separate consideration to the area's fishery and wildlife opportunities.

The quality of the fishery resource in the 47 mile segment of Licking River from the upper limits of the considered Royalton Reservoir site downstream to West Liberty r anges from moderate to good. In general, the considered Royalton Reservoir will improve the fishery resources in the area of project influence. The 1,080 acre seasonal pool will provide a fishery to an area in need of fishing opportunities and water quality control releases would improve the habitat of the river downstream to West Liberty. However, channelization of Licking River as described herein would destroy about 16 miles of stream habitat temporarily. The Royalton Reservoir is expected to provide about 16,200 fisherman days annually. The 10 mile portion of the Licking River from the dam to Salyersville and the 32 mile segment downstream to West Liberty will annually receive 1,200 and 3,300 man-days of fishing respectively. Total net fishery benefits accruing to the projects are $23,000.

Wildlife habitat within the project area is of low to moderate value. Average annual hunting pressure within the Royalton Reservoir area is estimated at 250 man-days. An additional 250 man-days of hunting occur on the river bottoms from the damsite downstream to Salyersville. Construction of Royalton Reservoir and development of the downstream flood plain industrial complex will result in a projected loss of about 370 man-days of hunting annually. To mitigate this loss to the wildlife resources of the area the Bureau of Sports Fisheries and Wildlife has suggested that a block of land between the arms of Puncheon Creek and Salt Lick Branch be purchased in fee at Federal expense. This land (approximately 1,000 acres) is proposed to be made available to the Kentucky Department of Fish and Wildlife Resources for wildlife management purposes. This forest habitat is suitable for wild turkey management. Introduction of wild turkeys on this area would provide

about 2,000 man-days of hunting annually, valued at $7,000. The 1,000 acres of land required for this purpose can be furnished from lands purchased for other project purposes. Additional lands acquired in accordance with the joint land acquisition policy can be managed for bob-white quail and cottontail rabbits. The Regional Director of the Bureau of Sports Fisheries and Wildlife has made seven recommendations as follows:

a. A minimum flow of 17 c.f.s. be maintained in the Licking River below Royalton Dam;

b. The natural vegetation on the banks of the Licking River be left undisturbed and protected within a strip 10 yards wide on each side of the river for a distance of 8 miles downstream from Royalton Dam;

c. Determination of number and elevation of multi-level outlets be coordinated with the Kentucky Department of Fish and Wildlife Resources, the Federal Water Pollution Control Administration, and this Bureau;

d. Detailed plans of the reservoir site for recreational zoning, clearing, and public access be developed cooperatively by the Corps of Engineers, Bureau of Outdoor Recreation, Kentucky Department of Fish and Wildlife Resources, Kentucky Division of Boating, any other interested agencies, and this Bureau;

e. Wildlife losses be mitigated by acquisition of 1,000 acres of land at Federal project cost;

f. All lands and water area within Royalton Reservoir Project, excluding lands which may be reserved for intensive development of general recreation, or for safety, efficient operation, or protection of public property, be made available for administration by the Kentucky Department of Fish and Wildlife Resources under a General Plan for Fish and Wildlife Management in accordance with provisions of the Fish and Wildlife Coordination Act;

g. You include language in your report recommending that additional detailed studies of fish and wildlife resources be conducted, as necessary, after the project is authorized, in accordance with the Fish and Wildlife Coordination Act, and that such reasonable modifications be made in authorized project facilities as may be agreed upon by the Director, Bureau of Sport Fisheries and Wildlife, the Chief of Engineers, and the Commissioner of the Kentucky Department of Fish and Wildlife Resources for the conservation and improvement of these resources.

The District Engineer's comments on the above recommendations follow in the same order.

a. The District Engineer's plan provides storage for a seasonally adjusted flow of 14.3 cubic feet per second for water quality control. Variations between maxmimum summer-time and winter-time releases for water quality are expected to range from 14.3 c.f.s. in July to 5.3 c.f.s. in December. These flows will contribute to an improvement in the quality of flows through the Salyersville area. In addition storage is provided for 3.5 cubic feet per second for water supply which will contribute to an improvement in quality flow downstream to the point of withdrawal.

b. The District Engineer's plan provides that local interests will furnish sufficient interest in abutting land around the streams and channel in the Royalton/Salyersville reach to permit expenditure of funds for park-like development and general beautification, except for a reach immediately downstream from the dam which is proposed to be acquired for recreation including tailwater fishing. The proposed plan includes funds for landscaping the stream banks which is expected to stimulate local interest in making the banks available for public use.

c. The District Engineer proposes to coordinate the elevation of multiple level outlets with the Bureau of Sports Fisheries and Wildlife. The Bureau should coordinate with other agencies to assure that the outlets are located at optimum elevations.

d. The District Engineer, in accordance with existing laws and policy, proposes to develop detailed recreation plans cooperatively with the managing agency.

e. The District Engineer's Report contains provisions for land acquisition suitably located and of suitably sized units to permit management of a 1,000 acre unit as recommended.

f. The District Engineer proposes to license all lands to the Kentucky Department of Fish and Wildlife Resources that are not required for project operation and not leased to a recreation managing agency in accordance with applicable law and policy.

g. A recommendation in the District Engineer's report includes language that authorizes the Chief of Engineers to make "such modifications as in his discretion may be found advisable- - - - -." Within this purview, the language in the authorizing document and other applicable legislation, post authorization changes can be considered to reflect the views of the mentioned agencies. The District Engineer concurs in the need of post authorization studies.

The Federal Water Pollution Control Administration, Department of Interior, has conducted an investigation to determine the need for and value of water supply and water quality control storage in the considered Royalton Reservoir. The scope of the investigation was limited

to the area above Cave Run Reservoir. Sufficient storage is included in Cave Run Reservoir to meet all downstream water supply and water quality needs. The study focus is on water supply and water quality needs of the Salyersville-West Liberty area. The report findings show a year 2020 water supply need at Salyersville of 3.5 c.f.s. and a need of 1.1 c.f.s. at West Liberty. This 1.1 c.f.s. is included in the 3.5 c.f.s. required at Salyersville. The minimum annual benefit to be derived by meeting this need is $18,200. */

The point of greatest need for water quality control is Salyersville. Based on 85 percent removal of ultimate first stage biochemical oxygen demand, an annual draft-on-storage of 1,950 acre-feet **/ will be needed by the year 2020. This storage would maintain a flow of 14.3 c.f.s. at Salyersville for the maximum need month excluding water supply flow during a one in ten year recurrence interval drought. The minimum annual benefit to be realized by providing this storage would be $30,700. */ All annual benefits are based on a 100 year amortization of capital costs at an interest rate of 3-1/8 percent plus estimated annual operation and maintenance costs.

A physical description of the watershed and a description of its people, its geology, and its soils are included in a report received from the U. S. Department of Agriculture, Soil Conservation Service. The upper Licking River basin is depicted as a declining rural area where family income is low, where unemployment or underemployment is high and where farming as a way of life is decreasing at a rapid rate.

Overgrazing, burning, over-cutting, and past cultivation of lands which are now forested have contributed to a poor hydrologic condition throughout much of the upper basin. This condition results in severe to critical erosion on most upland areas. Floodwater and sediment damage occur to crop and pasture land and other agricultural improvements in the Licking River flood plain. This has a limiting effect on its use for agricultural purposes and contributes to the depressed agricultural condition. It is assumed that the area between Royalton and Salyersville will change from agricultural to urban use and that the flood plain between Salyersville and Cave Run Reservoir will develop into intensified agricultural use. Works of improvement considered by the Soil Conservation Service to be essential to improve conditions in this area consist of appropriate land treatment measures and flood control structures.

The Soil Conservation Service recommends an accelerated land treatment program to provide protection to the watershed lands, to reduce sediment production, to assure benefits to agricultural flood plain lands, and to protect structural measures and the land development. This program is in addition to going programs and would

*/ The current report contains estimated annual benefits of $30,000 for water supply and $52,000 for water quality control based on more refined analysis of alternative costs and on 4-7/8% interest rate.

**/ Federal Water Pollution Control Administration estimate.

provide technical and cost sharing assistance to landowners for both vegetative and mechanical practices on forest and open lands above river mile 264.0 and on those flood plain lands along the Licking River to the Cave Run Reservoir on which project benefits have been evaluated. Cost of this accelerated land treatment program is estimated at $1,773,000 of which $1,440,000 would be Federal and $333,000 non-Federal. This includes 80-20 Federal - local cost sharing for installation which is consistent with the provisions of Section 214 of the Appalachian Regional Development Act.

Seven sites on Licking River tributaries have been investigated by Soil Conservation Service for flood control structures. All sites are suitable for construction of flood water-retarding dams. However, Soil Conservation Service has recommended sites on Rockhouse Fork, Burning Fork, and Mash Fork for accomplishment only. These structures are compatible with the comprehensive development plan and are included in the selected plan. Estimated first costs and cost sharing rates for those three structures are in accordance with Soil Conservation Service estimates and recommendations. The Soil Conservation Service has stated that Rockhouse Fork and Mash Fork structures have potential for recreation development and has recommended a joint authorization for development of land and water resources of the Upper Licking River Watershed by the Corps of Engineers and the U. S. Department of Agriculture. The District Engineer's plan incorporates the recommendations of the Soil Conservation Service and includes three structures, a multiple-purpose structure on Rockhouse Fork and two single-purpose floodwater retarding structures on Burning Fork and Mash Fork, and the recommended accelerated land treatment program.

The Federal Power Commission made an appraisal of the conventional and pumped storage power potential in the considered Royalton Reservoir. The study of the conventional power potential was based on the use of the project in the best interest of hydroelectric power. An economic analysis of an installation definitely indicated that the specific power facilities for this conventional power were economically infeasible. Two types of pumped storage projects were considered. A run-of-river type of development was ruled out immediately. Secondly, a hilltop headwater reservoir utilizing Royalton Reservoir seasonal pool as the tailwater pool was investigated. A favorable B/C ratio was indicated for this plan, but the costs would exceed the costs of a comparably financed steam plant. The District Engineer recognized the attractiveness of the detached type of pumped storage but considers that the benefits to the Nation do not warrant including it in the plan at Federal cost at this time. The District Engineer's plan has sufficient flexibility so that pumped storage could be added by others at any time under license from Federal Power Commission provided that its addition was in harmony with sound economic and reservoir management principles.

The U.S. Bureau of Mines, Department of the Interior, has made an estimate of coal reserves in the Licking River basin upstream from Royalton, Kentucky. A minimum of 19 coal horizons occur in the basin. A few have thickness, continuity, and quality to support large continuous operations. The Upper Elkhorn No. 3 coalbed is one of these and is presently being mined from beneath the Licking River basin. Production from this area totaled 203,000 tons in 1965. The Bureau of Mines estimates that there are 18,500,000 tons of recoverable coal beneath the considered Royalton pool and that royalties on this coal would amount to about $4,620,000. Current project cost estimates include an allowance for these resources.

United States Bureau of Public Roads officials have offered to assist in determining highway relocation costs and advised that Federal-aid highway funds may not be used to relieve local interests of obligations assumed as a condition of undertaking a water project.

Correspondence was received from the Economic Development Administration pledging the agency's resources to those interests who will implement developmental aspects of the comprehensive plan and furnishing information concerning types of grants, loans, and technical assistance they could provide.

Various non-Federal agencies have been cooperative and responsive during this investigation.

Favorable comments have been received from various state agencies. The Department of Commerce, Commonwealth of Kentucky, supports the considered Royalton Reservoir and will assist in the formation of an industrial development foundation appropriate in terms of program and geographical scope for this project. Further, the Department will provide technical assistance in financing the purchase and development of industrial acreage created by the project and will promote the industrial development potential of the area. The Director of the Division of Water, Department of Natural Resources, Commonwealth of Kentucky, who is also Executive Director of the Kentucky Water Authority, has endorsed the project. The administrator of the Kentucky Area Development Office, Commonwealth of Kentucky, has pledged the Commonwealth to provide necessary leadership and technical skills to help design a comprehensive development program for this project area and will use the full resources of state government to carry out the program in an effective and coordinated manner. The Kentucky Department of Highways has reviewed all roads affected by the considered Royalton Reservoir and has described and listed all roads recommended for alteration or relocation. These recommendations are based on existing traffic, however the Highway Department intends to request improvements to standards for projected traffic if future information justifies. Access roads to possible recreation sites have not been included in their recommendations. The Department requests that they be informed of any releases for loss of access sought from individuals that would be left with isolated properties.

13. DISCUSSION

The purposes of this interim report are to determine the feasibility of constructing works for the development of the water and related resources of the Upper Licking River Basin such that, not only will the existing water related problems be lessened or solved, but also the works of improvement will help provide expanding economic opportunities in the area in order that increased production of goods and services in Appalachia will lead to enduring growth. If this latter objective is obtained, the area will improve its relative position in the economy of the United States.

Under the Appalachian Regional Development Act of 1965, stimulating the economic development of the Appalachian region is an integral part of national economic policy. As expressed in the Act, this development should be achieved in the most efficient manner possible and with minimum expense and disruption to other regions. In the framework set by these objectives, water resource development is one of several programs to make possible and stimulate Appalachian growth. The focus on economic stimulation distinguishes this plan from many previous resource development programs, where this need was far less significant. This report recognizes the role which regional development plays in national development and growth, and the role which water resource development holds in the generation of enduring regional growth.

The Upper Licking basin is typical of many parts of Appalachia, having a high unemployment rate and almost no industrial development. Some of the factors contributing to this situation in Appalachia have been lack of access and lack of developable real estate. In this basin access has been provided by the Mountain Parkway which now provides for ready access to markets. Additional improvements and the completion of the Appalachian developmental highway program will provide excellent access in all directions. The water project elements previously described will provide flood protection to existing development and to approximately 1800 acres of flood plain lands which can then be developed. These 1800 acres are the only land in the general area susceptible to early development. The plan will meet the area's expected water supply and water quality control needs and will improve fishing, hunting, and general outdoor recreation within the recreation market area. The plan was specifically designed to provide a degree of protection that would induce development of the flood plain area. The water control plan was designed, as a system, to maximize developmental response. One objective of the plan is to provide a level of services which will permit the economic development to take place. A reduction in project services would preclude this development from occurring, while an increase would not result in any significant increase in expansion effects. Within the system, a least cost balance between parts of the plan was determined.

The plan selected consists of five elements, namely: (1) a multipurpose reservoir on the Licking River near Royalton, Kentucky (CE); (2) channel improvements on the Licking River and State Road Fork (CE); (3) three small structures on tributaries of the Licking River upstream from Salyersville (USDA); (4) an accelerated land treatment program (USDA) and (5) industrial site preparation on lands made flood-free by the first three elements with associated improvements of public facilities (non-Federal for basic responsibility).

Element one, Royalton Reservoir, provides flood control storage which, in conjunction with elements two and three of the plan, will not only remove the flood threat from the existing development, but will provide the degree of protection needed to induce industrial development of the area. In addition, the reservoir will supply water for municipal and industrial uses and that required for water quality control under full development of the area. Recreation has been planned for the project, including an increase of the pool area during the summer season of maximum recreational use. The plan of development for Royalton Reservoir contemplates highway alterations and relocations to maintain normal traffic flow in the vicinity of the reservoir. State Route 7 would be raised for about 0.4 miles and relocated for a distance of about 12 miles. About 2.0 miles of State Route 542 would be relocated and an additional 0.1 mile of this route would be raised. To provide necessary access, relocation of about 15.0 miles of county roads is required. Seven small cemeteries containing about 165 graves would be relocated. About 2 miles of gas lines would be relocated and 24 gas wells altered. Approximately 30 miles of power lines and 30 miles of telephone lines would be relocated or altered as required.

Implementation of the Royalton Reservoir plan of development would require relocation of about 275 families including those requiring relocation by reason of isolation. These families would be resettled in areas of their own choosing. An amount to cover resettlement costs of these families has been included in the cost of lands and damages for the Royalton Reservoir project.

Elements two and three, the channel improvements and three SCS structures, are not only an integral part of the flood protection on the main stem, but also provide the necessary controls to the developable, contiguous tributary areas in order that they may be properly developed. In addition the Rockhouse Fork structure will include a recreational development. Project costs are included in Licking River Channel Improvement to provide for landscaping the stream banks downstream from the Royalton Reservoir in order to assure that the resulting urban community will be founded in an aesthetically pleasing setting.

Element four consists of an accelerated land treatment program to provide protection to watershed lands, to reduce sediment production, to assure benefits to agricultural flood plain lands and to protect the structural measures and developmental land.

Element five is that part of the plan to be carried out essentially by non-Federal interests, which will be the development of the industrial, commercial, and residential complex on lands provided flood protection by the other elements of the plan. This will include site preparation; access roads, extension of utility systems and other community services.

The project plan is not separable into its component elements since attainment of the three objectives (expansion in employment opportunities, improvement in environment for regional economic development, and national income expansion) cannot be reached without the total plan. The indices of economic performance, that are developed in the following Section, show that the plan clearly attains the first two objectives. Because a significant portion of the projected expansion in employment would be reflected in national income gains, it would appear that the project plan is also desirable in expanding national income. Because the plan was formulated to be as functionally efficient as possible and also to achieve maximum developmental response, it does not, in its setting, provide sufficient user benefits to the present levels of area economic activity to exceed project costs. It is only after the plan has begun to perform, to induce growth and development, that a comparison of the values of its goods and services to users will exceed annual charges.

As stated in the Appalachian Regional Development Act of 1965 (PL 89-4), the region lags behind the rest of the nation in its economic growth and its people have not shared properly in the nation's prosperity. The purpose of the Act therefore is to assist the region in meeting its special problems, to promote its economic development, and to establish a framework for joint Federal and State and local efforts toward providing the basic facilities essential to its growth. Since the area has lagged behind in its development, there is not the fiscal base which will, at this time, permit the local interests to pay or contribute in kind the non-Federal first costs of elements two and three of the plan; -- namely, lands, easements and rights-of-way -- and also to undertake the capital outlays necessary for the preparation of industrial sites. In order that growth and development may occur in the area, which will not happen without the project, and without significant local participation and leadership, it is proposed that all first costs of elements one, two, and three be initially funded by the Federal Government.

The realization of the potential benefits of the plan are dependent to a large degree, on the initiative and vigor of non-Federal interests in attracting industry to the area. In order to assure that non-Federal (State or local) interests have the working tools for attracting industry, it is essential that a properly constituted public or quasi-public body, or bodies, be established, which should have the minimum authority to (1) exercise the right of eminent domain for developmental purposes, (2) float bond issues or have other revenue sources sufficient to assure orderly acquisition and development of necessary lands, (3) enter into

contracts with the United States and the Commonwealth of Kentucky (if the body is not a political sub-body of the State), and (4) zone and control land use.

After the project plan is in operation (including the start of industrial development) the fiscal condition of the area will improve such that at some future date the non-Federal costs can be repaid. Local costs for water supply and recreation will be paid for as provided in the Water Supply Act, PL 85-500, and the Federal Water Recreation Act, PL 89-72. It is proposed that repayment by local interests of the non-Federal flood control costs may be deferred, at their request, for a period of ten years. It is proposed that repayment be made within the life of the project but in no event to exceed fifty years after repayment begins and no interest shall be charged on the local interest costs for ten years. The interest rate used for purposes of computing interest during construction and interest on the local interests costs shall be determined by the Secretary of the Treasury, as of the beginning of the fiscal year in which construction of the project element is initiated, on the basis of the computed average interest rate payable by the Treasury upon its outstanding marketable public obligations, which are neither due nor callable for redemption for fifteen years from date of issue.

Residents of the area are widely divided in their attitudes toward future economic development. The public hearing and subsequent correspondence indicated that the residents within the Royalton Reservoir area are opposed to the project and plan of development, whereas those outside the reservoir area and civic and business organizations favor the plan.

14. CONCLUSIONS

Flood Control provided by the comprehensive plan will allow development of lands which are now flooded annually. Water supply and water quality control features of the plan will provide for existing needs as well as the developmental requirements. The general recreation and fish and wildlife recreation will serve the local area as well as some outside demand. Each of the five elements of the plan -- Royalton Reservoir, channel improvements, floodwater retarding structures, land treatment, and the developmental element -- contributes to the plan's economic efficiency. A summary of annual benefits and charges is given in Table 18.

Table 18. Summary of annual benefits and charges for comprehensive plan ($1,000) 1/

Type of benefit	Regional account only ($)	National account only ($)	Both Regional & National accounts ($)	Total Regional account ($)	Total National account ($)
User	-	84	808	808	892
Redevelopment	229	-	171	400	171
User plus Redevelopment	229	84	978	1,208	1,063 2/
Development	26,105	-	5,845	31,950	5,845
Expansion (Development & Redevelopment)	26,334	-	6,016	32,350 3/	6,016

Annual Economic Charges:

Water Resource Plan (Elements 1-4)	2,433 2/
Area Development Plan (Element 5)	4,317
Total Annual Charges (Elements 1-5)	6,750 3/

1/ For more detailed breakdown of annual benefits and charges, see Table 12 (page III-1-56) and Table 1 (page III-1-35), respectively.
2/ Utilized in performance index No. 1.
3/ Utilized in performance index No. 2.

Since this report places unusual emphasis on the economic relationships which now exist and which may be developed between the regional and the national economies the regional and national accounts (Table 18) deserve emphasis for they are subject to various interpretations, some of which have far-reaching implications in the evaluation of the Appalachian resource projects. Most important are the assumptions used in proportioning total local-hire wages between the regional account only and the joint (regional-national) account. It could be maintained that, in the absence of proof that economic development would not occur otherwise in some part of the nation, all local hires are only of benefit to the region and have no place in the national account. This interpretation should be tempered by the fact that the Appalachian Regional Development Act makes the development of this region and the effective employment of its people an integral part of national economic policy. The water resource plan will clearly induce considerable employment in an area of chronic and persistent unemployment, and will bring into the national economy factors of production that have stubbornly resisted inducement to move to employment centers. The water resource plan creates a new environment for growth in a distressed part of Appalachia, and should stimulate new hope and creativity in the population.

In order to reach or approach the goals of the Appalachian program, the plan developed herein was formulated in accordance with the major objectives. The estimated benefits and costs of the plan afford a basis for generalized appraisal of anticipated performance with respect to these objectives.

One index of performance which is related to economic efficiency can be evaluated by dividing benefits by costs as generally developed for water resource projects. The numerator contains annual user benefits plus those employment benefits attributable to direct construction and operation of the water project (redevelopment benefits). The denominator is the annual cost of the water project. Such an index, computed below, expresses the minimum index of performance in regard to national income:

$$\frac{1,063}{2,433} = .44$$

Another index of performance gives a relative measure of the contribution that Royalton Reservoir development would make to the objective of expanding employment in the Appalachian Region. The numerator consists of increased wage payments for construction and operation of the water project plus wage and salary flows to the region generated by the associated private investments. The denominator is the annual cost, both public and private, necessary to provide the expansion in employment opportunities.

$$\frac{32,350}{6,750} = 4.8$$

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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

CHAPTER 2

TAMAQUA, PENNSYLVANIA LOCAL PROTECTION PROJECT

Office of Appalachian Studies

Corps of Engineers

July 1969

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PART III

PROJECT ANALYSES

CHAPTER 2

TAMAQUA, PENNSYLVANIA LOCAL PROTECTION PROJECT

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CHAPTER 2 - TAMAQUA, PENNSYLVANIA LOCAL PROTECTION PROJECT

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PART III

PROJECT ANALYSES

CHAPTER 2

TAMAQUA, PENNSYLVANIA LOCAL PROTECTION PROJECT

SECTION I - PROJECT SUMMARY

1. PHYSICAL DESCRIPTION

Tamaqua is a borough located in eastern Schuylkill County, Pennsylvania, near the headwaters of the Little Schuylkill River. It is largely in the floodplain of the river and its two tributaries, Wabash and Panther Creeks, which enter the river in the borough. It has been subject to frequent flooding from intense rainfall on the watersheds of the three streams, or from a thunderstorm centered over only one watershed. Exhibit 2-1 is the project location map which shows the alignment of the project and the urban area which includes the lowermost reach of Wabash Creek, and the existing culvert.

Above Tamaqua, a four-reservoir flood control system is under construction by the Soil Conservation Service (SCS) of the U.S. Department of Agriculture. These structures are located on tributaries of the Little Schuylkill River and will control the runoff from 34.0 square miles, about 79 percent of the drainage area above the gaging station at Tamaqua. Location of these reservoirs and their status as of January 1969 are also shown on exhibit 2-1.

Because of its reasonably straight and unobstructed channel through the Borough, Panther Creek has not been a flood problem in the past except during periods of very high flows in Little Schuylkill River. With the completion of the SCS reservoirs, the channel of Little Schuylkill River will have adequate capacity to pass flood flows from Panther Creek, thus the principal remaining flood threat is from storms centered over the 3.7-square mile drainage area of Wabash Creek. Wabash Creek flows into the Little Schuylkill River at a point approximately 2,000 feet south of West Broad Street, in the main business area. Encroachments into the flood plain and the channel of the creek have diminished its discharging capacity to the extent that damages are incurred during moderate, frequently recurring floods.

2. PROJECT IMPACT

The proposed project would intercept the floodwaters of Wabash Creek and discharge them through a tunnel into the Little Schuylkill River below the business district. The proposed improvements would

provide adequate flood protection to the area which is presently subject to frequent (almost twice a year) flooding by Wabash Creek. The project design discharge is a flood with an estimated frequency of recurrence of once in 100-years.

The Borough's limited financial capability precludes an adequate urban renewal program without Federal assistance. Since the present Federal policy, as expressed in Executive Order 11296, required evaluation of flood hazards affecting any construction involving Federal expenditures, alleviation of the flooding is imperative to the future development of this blighted area of Tamaqua. An urban renewal plan was prepared for Tamaqua in 1964. The preparation of the plan was financed under Section 701 of the Housing Act of 1954 from funds administered by the Bureau of Community Development, Pennsylvania Department of Commerce. The plan has been adopted by the Borough's Council and has been partially implemented by the passage of the recommended zoning ordinance. However, an application for a renewal grant will not be made by the Borough until the flooding problem is solved. The effects of the proposed improvements would be physically limited to Tamaqua and the adjacent populace although there are additional national income effects which exceed the local effects.

3. COSTS AND BENEFITS

Total costs of the Tamaqua Local Protection project are estimated to be $2,355,000, equivalent to an annual charge of $82,000. The cost of the additional development necessary to produce expansion benefits are estimated to be $5,200,000, equivalent to an annual charge of $287,999. Annual benefits of the project are estimated as follows:

Benefit Category	Income National	Income Regional
User	$127,000	$127,000
Expansion		
Redevelopmental	11,000	24,000
Developmental	287,000	723,000

Based on the preceding, the projects' index of performance would be 1.7 for the objective of national income expansion, and 2.0 for increasing regional income.

4. COOPERATION REQUIRED FOR CONSTRUCTION

Existing legislation and administration directives require non-Federal interests to acquire all lands, easements, and rights-of-way for a local protection project. In addition, they are required to alter all highways, bridges, and utilities affected by the project;

Lofty
Creek
Neifert
UNDER
CONSTRUCTIO
Creek
Pine
Creek
54
Creek
54
Pine
3
COMPLETED
CO
Creek
Locust
Locust
Lake

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DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)

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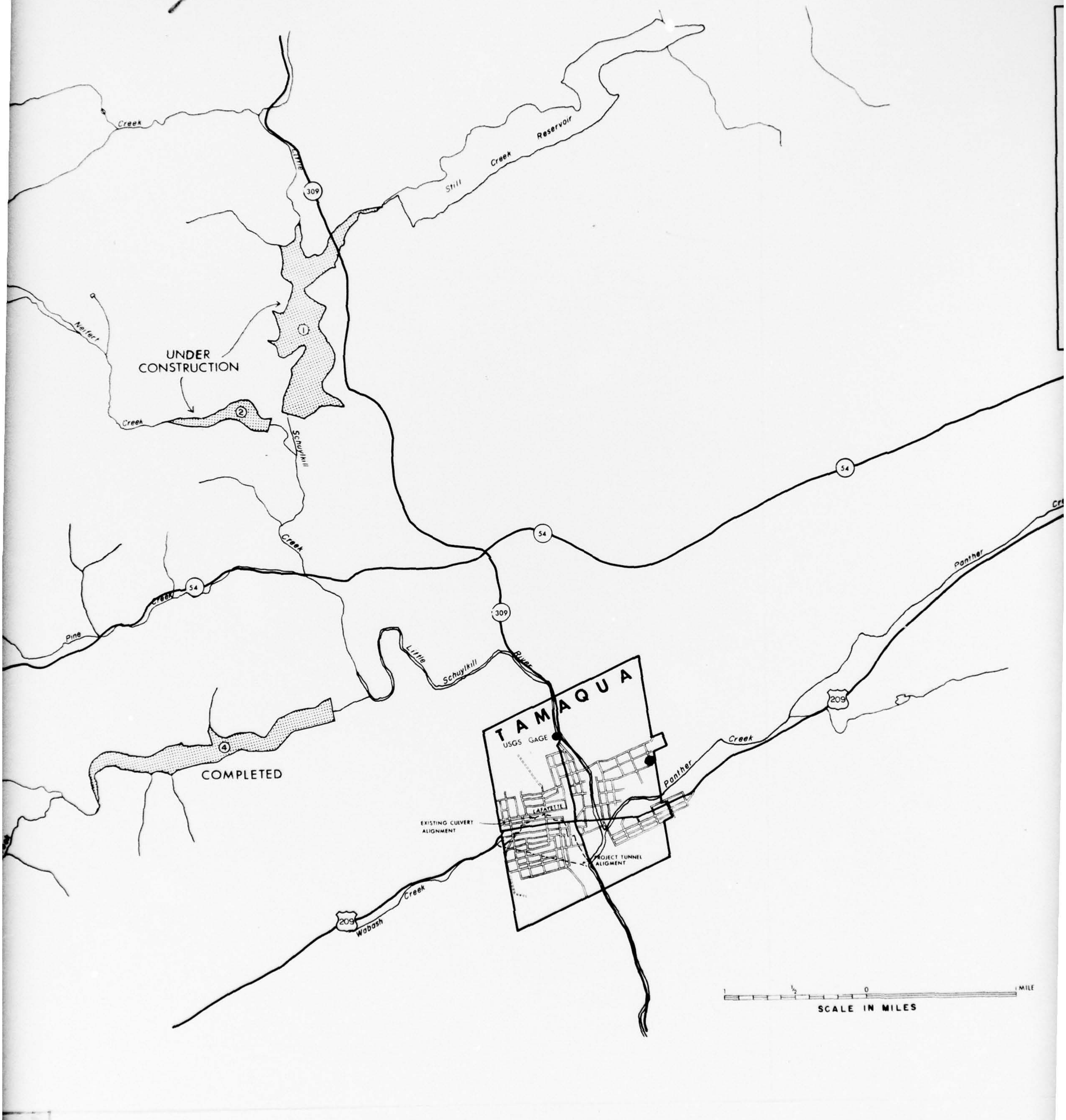
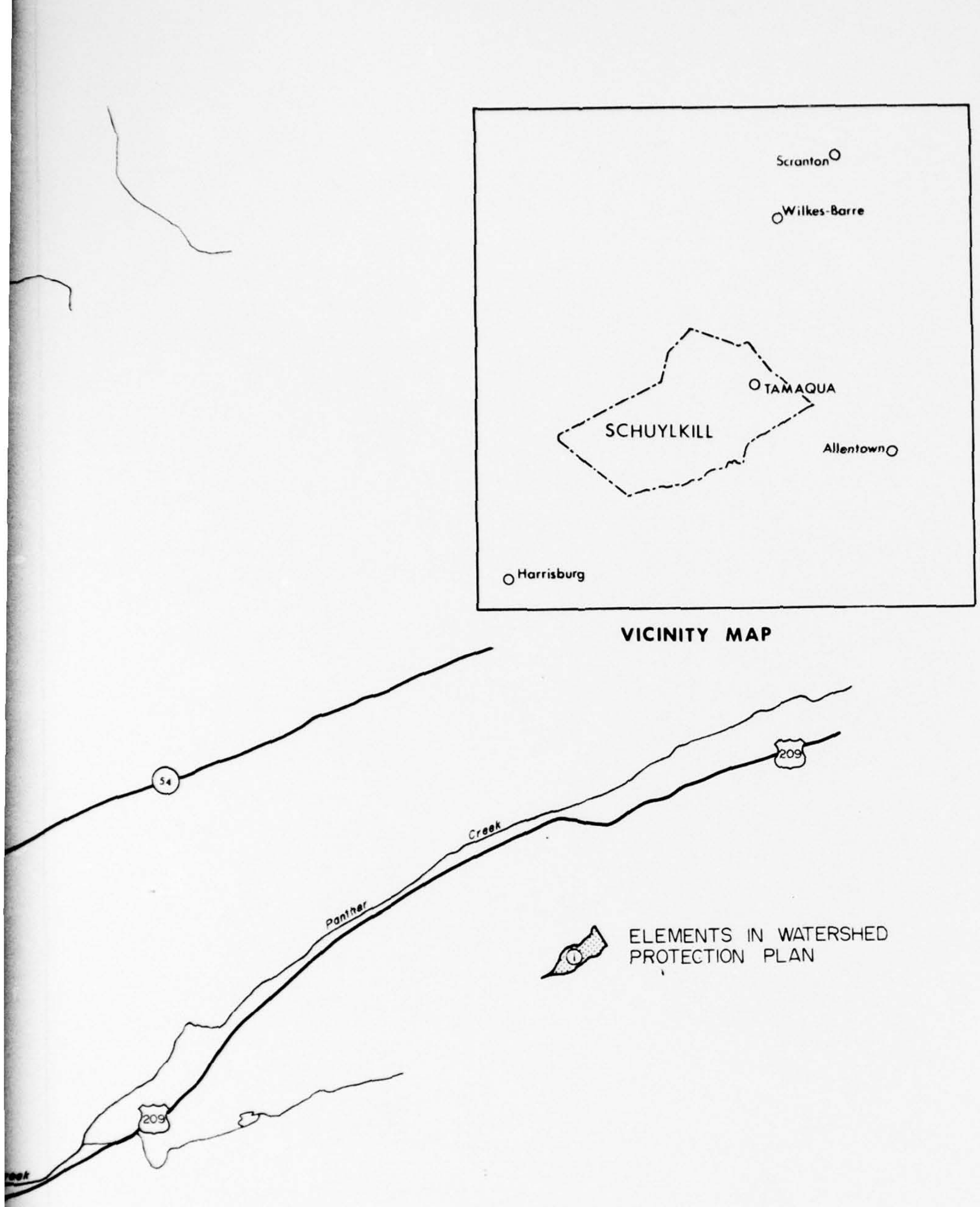

Creek
Little
309
Still
Creek
Reservoir
Neifert
UNDER
CONSTRUCTION
Creek
Schuylkill
54
Creek
Pine
Creek
Little
Schuylkill
River
Panther
TAMAQUA
USGS GAGE
COMPLETED
EXISTING CULVERT
ALIGNMENT
PROJECT TUNNEL
ALIGNMENT
Panther
Creek
209
Wabash
Creek
SCALE IN MILES
1 MILE

3



FLOOD CONTROL STUDY
TAMAQUA, PENNSYLVANIA

LOCATION MAP

OFFICE OF APPALACHIAN STUDIES NOVEMBER 1968

III-2-3 EXHIBIT 2-1

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hold and save the United States free from damages due to the construction works; maintain and operate the project; and prevent encroachments which would diminish the project's flood control effectiveness.

The estimated non-Federal first cost is about $76,000 and the annual cost, including operation and maintenance, is about $4,600.

SECTION II - PROJECT FORMULATION

5. GENERAL

Tamaqua is typical of many of the communities in the anthracite region of Pennsylvania. Founded to exploit the coal resource, Tamaqua grew as the demand for coal grew, and its economy became almost completely dependent upon the vagaries and whims of the nation's need for coal. This single-commodity economy developed only those skills and talents necessary for the mining and transportation of anthracite. As the cost of underground mining grew and other fuel sources became more competitive, demand decreased sharply and the mine operators turned rapidly to mechanization and strip mining. These shifts in mining technology resulted in a high rate of unemployment, which produced a reservoir of excess labor with talents and skills no longer useful in the area. In addition, vast strip-mined areas were abandoned and subsequent acid runoff and culm piles have produced polluted and silted streams and a devastated landscape.

Unable to obtain employment, many of the unemployed outmigrated in search of jobs. The magnitude of this out-migration was substantial, constituting about 17 percent of Tamaqua's population during the period from 1950 to 1960. While these losses were occurring in Tamaqua, even greater losses were taking place in nearby communities. Tamaqua owed its relative well-being during this period to its location at the junction of U.S. Route 209 and State Route 309 and its proximity to the main line of the Reading Railroad. This location has fostered a steady increase in wholesale and retail trade.

Tamaqua serves as one of the most important retailing centers in Schuylkill County. In 1958, although having only 6 percent of the population, the Borough accounted for over 10 percent of the retail sales in the county. Despite a history of downward trends in many areas of its economy, and despite losses of its population due to outmigration (common to many Appalachian communities), Tamaqua continued to retain its function as a retail and service center. The data tabulated below shows the relative stability in retailing, in terms of establishments and sales, compared with Schuylkill County as a whole.

	1948	1954	1958
No. of Establishments	203	187	208
Sales - Tamaqua ($1,000)	$ 13,080	$ 13,162	$ 15,764
Sales - Schuylkill Co. ($1,000)	$133,209	$146,082	$152,156
Percent Tamaqua Sales of Schuylkill Co.	9.8	9.0	10.3

Source: U.S. Census of Business

Due to its strategic location near the new locust Creek State Park, which will serve as a center of tourism and recreation for the region, Tamaqua can expect to expand its function as a retail and service center by serving as a hub for the recreation area, providing hotel and motel accommodations, dining places, and other retail services.

The major premise of the planning effort was that improvements proposed should be those that would solve or contribute to the solution of those problems which stand most in the way of development, contribute significantly to the release of development potential and were regarded as important and relatively urgent. Tamaqua meets these criteria and major impediments to present economic activity and future growth were identified as: (1) The damages associated with recurrent flooding of the business district; and (2) Lack of land with a sufficiently flood free environment that would allow implementation of the proposed plan for renewal and rehabilitation of the downtown business district.

The Borough has been actively seeking relief from flooding for nearly 20 years. The first plan of protection was offered by the State of Pennsylvania in 1950. However, with its shrinking tax base and high rate of unemployment, Tamaqua was unable to meet the local cooperation requirements. However, within the past 7 years, the Soil Conservation Service has initiated a program of reservoir construction in the headwater regions of Little Schuylkill River which will protect Tamaqua from flooding by this stream (see exhibit 2-1). Thus, the only threat of flooding remaining will be by Wabash Creek. In spite of the nearly semi-annual flooding, Tamaqua continues to grow as a regional trade center and has shown a steady increase in retail and wholesale trade even though the county as a whole has shown losses.

6. ALTERNATIVES AVAILABLE FOR MEETING THE NEEDS

In addition to non-structural measures four schemes were considered in developing structural measures to prevent flood damages from Wabash Creek. At present, Wabash Creek discharges into a stone arch culvert west of the Borough and is carried for about four thousand

feet underground through the Borough. The culvert was built in the early days of Tamaqua's development as a major anthracite mining town. Since it was first constructed, private dwellings and commercial buildings have encroached with their foundations on the waterways. Deposits consisting of silt and wastes from coal mining and processing have further restricted the area of the water passage. Sharp curves in the conduit also cause turbulence which limits the capacity. The result is that during heavy runoff the water backs up in the conduit, flooding basements and streets within the Borough.

Non-structural measures considered were: flood plain regulation; flood warning systems; and evacuation of the flood plain. Flood plain regulation has an economic cost in terms of lower utilization of land in the flood plain. Due to the current state of land development in the Tamaqua flood plain and since there is a paucity of land available for future development, flood plain regulation was not found to be an acceptable solution to the Borough's flood control problem. A flood warning system is valuable for flood damage reduction only as a supplement to other flood control measures and not as a substitute for them. Such a system when properly related to the rate of potential flooding in a basin, is valuable in reducing loss of life and monetary damage through evacuation of people and movable property from the flood plain. At Tamaqua, due to the steep topography surrounding Wabash Creek, the small drainage area involved (3.7 square miles), and the resulting quick concentration of flood runoff, a flood warning system would not be adequate. With respect to evacuation, removal of existing railroads, utilities, and other developments from the flood plain would not be acceptable and could only result in a loss of economic activity and further contribute to the economic problems of Tamaqua. Consequently, structural measures, if found feasible and economically justified, are essential to the solution of the present flood problem and to the stimulation of future growth at Tamaqua.

The limited capacity of the present conduit and complicated location and alignment made it impractical to enlarge and improve this conduit, therefore, other structural measures for flood protection of Tamaqua were investigated.

Alternate Schemes Investigated - Exhibit 2-2, General Plan, shows locations for the four alternate schemes studied.

a. Scheme One - Conduit Along Abandoned Railroad Right-Of-Way - Scheme One consists of a 3,680-foot long, 10-foot diameter reinforced concrete pipe lined with vitreous clay for 180° of its circumference. The pipe would be constructed within the Reading Company's abandoned railroad right-of-way from Wabash Creek, on the western boundary of the Borough, to the Reading Company's main tracks, located downtown. A 1,100-foot long, 10-foot wide outlet channel conveys the discharges from this point into the Little Schuylkill River.

b. Scheme Two - Conduit Along Broad Street - The considered construction of Scheme Two is identical to Scheme One. The route is the same except between the street intersections at Broad and Lehigh and at Broad and South Railroad Streets. Scheme Two, with a conduit 3,390 feet long, utilizes West Broad Street between these street intersections, but otherwise follows the route as in Scheme One.

c. Scheme Three - Tunnel Through Sharp Mountain - Scheme Three consists of a 2,930-foot long, 10-foot diameter, concrete-lined tunnel, with 180° of its circumference lined with vitreous clay. The tunnel would be constructed from Wabash Creek at the west boundary of the Borough, through Sharp Mountain and under the Reading Company's main tracks east of Orwigsburg Street. A reinforced concrete stilling basin would be constructed downstream of the railroad tracks. A 100-foot long, 10-foot wide outlet channel would be constructed between the stilling basin and Little Schuylkill River.

d. Scheme Four - Flood Control Dam - Scheme four would consist of an earthfill flood control dam and detention reservoir on Wabash Creek about 900 feet west of the Borough of Tamaqua. It was assumed that the existing conduit would operate at full capacity during flood flows and the reservoir would be designed to retain only excess flows. In order to provide protection equivalent to Schemes 1, 2 and 3, it would be necessary to retain all flood discharges over and above the maximum capacity of the existing conduit which was estimated to be 200-300 cfs. The height of the dam at the proposed location would be limited to about 60 ft. above stream level (Elev. 880), because of prohibitively high costs of relocation of Highway U.S. 209, and mine protection (or purchase of mineral rights in lieu of protection), which would be required for a higher structure. In addition, local interests object to relocation of a portion of the Odd Fellows cemetery which would also be required with a higher dam. The cost of the 60 ft. high dam was estimated to be about $350,000. The maximum storage which could be provided by the structure would be 560 acre-feet. Routing the Standard Project Flood (maximum discharge 2,200 cfs) through the reservoir with the spillway crest at Elev. 876 resulted in reducing peak inflow to the conduit from 2,200 cfs to 1,800 cfs. Similarly, the peak inflow to the conduit resulting from the 100 year (design) flood would be about 1,300 cfs. Therefore, construction of a flood control dam would only result in minor reductions in inflow to the outlet channel irrespective of whether the outlet channel consisted of the existing conduit with extensive improvements on one of the other schemes considered separately or in combination. Usually, there are certain advantages in reservoir construction through the use of space for multiple purposes. However, in this case a multiple purpose reservoir would not be feasible because of high sedimentation rates and the acidity of the waters of Wabash Creek.

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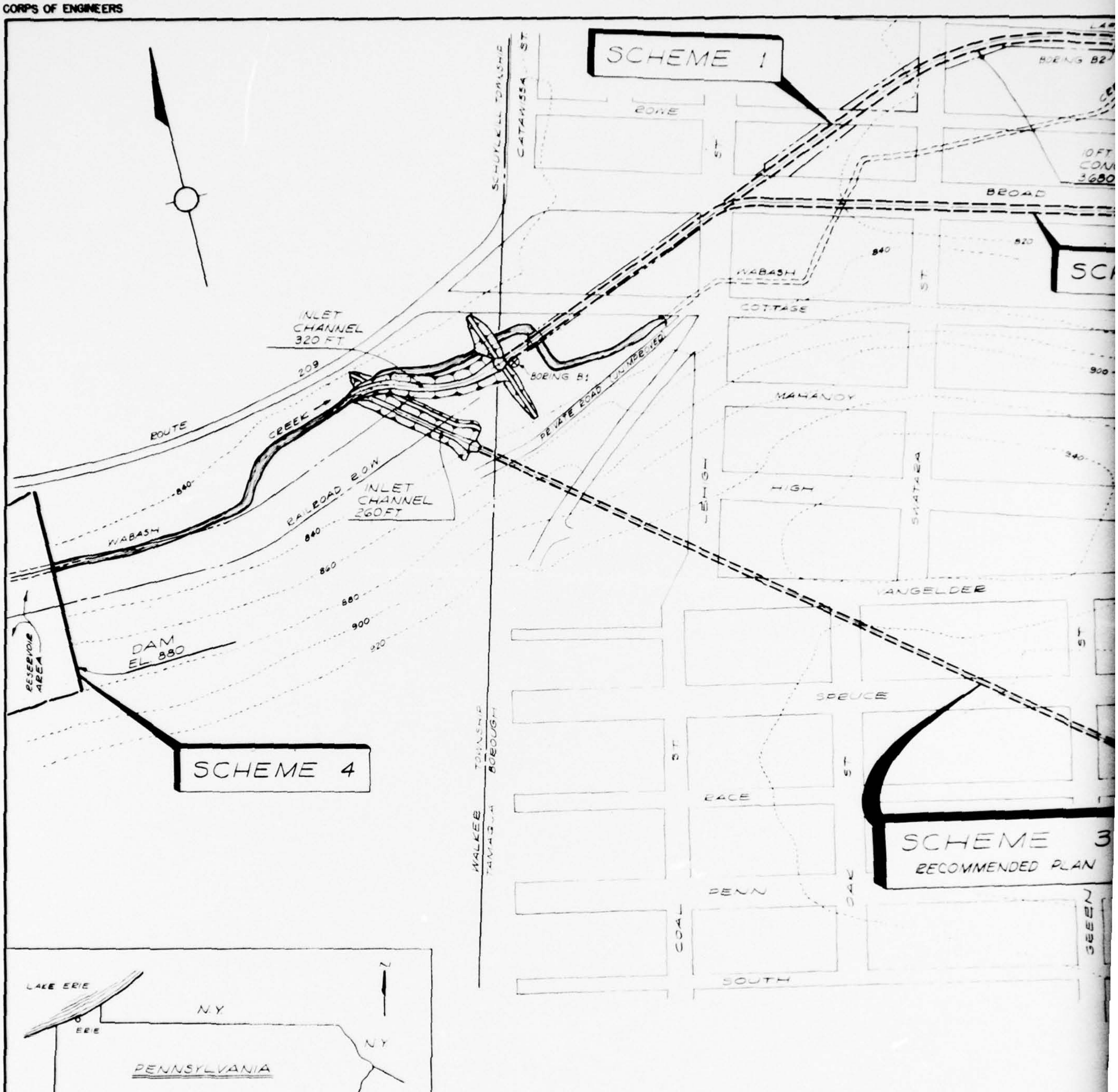

GENERAL PLAN

FIGURE 36 TAMAQUA LOCAL

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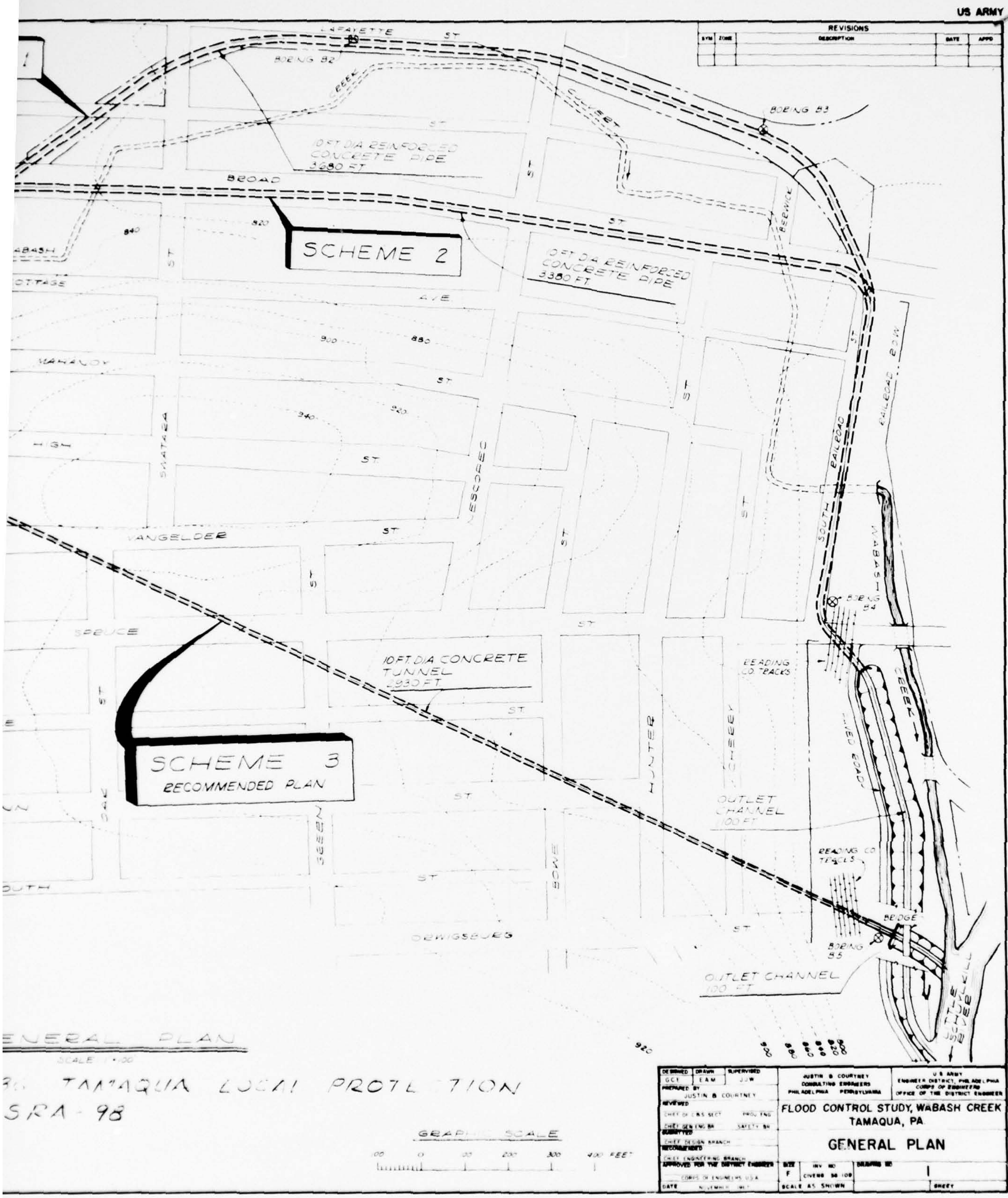
US ARMY
REVISIONS
SYM ZONE DESCRIPTION DATE APPD
LAFAYETTE ST
BORING B2
BORING B3
CREEK
SILVER ST
10 FT DIA REINFORCED CONCRETE PIPE 3680 FT
BROAD ST
SCHEME 2
10 FT DIA REINFORCED CONCRETE PIPE 3380 FT
BERWICK
WABASH
COTTAGE AVE.
MAHANOY ST
HIGH ST
SWATARA ST
NESCOPEC ST
SOUTH RAILROAD ST
RAILROAD R.O.W.
VANGELDER ST
SPRUCE ST
WABASH CREEK
BORING B4
READING CO TRACKS
10 FT DIA CONCRETE TUNNEL 4930 FT
SCHEME 3
RECOMMENDED PLAN
HUNTER ST
CHERRY ST
GREEN ST
BOWE ST
OUTLET CHANNEL 1100 FT
BRIDGE
BORING B5
ORWIGSBURG ST
OUTLET CHANNEL 100 FT
LITTLE SCHUYLKILL RIVER
GENERAL PLAN
TAMAQUA LOCAL PROTECTION
SRA-98
GRAPHIC SCALE
100 0 100 200 300 400 FEET
DESIGNED GCY DRAWN EAM SUPERVISED JJW
PREPARED BY JUSTIN B COURTNEY
JUSTIN B COURTNEY CONSULTING ENGINEERS PHILADELPHIA PENNSYLVANIA
US ARMY ENGINEER DISTRICT, PHILADELPHIA CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER
FLOOD CONTROL STUDY, WABASH CREEK
TAMAQUA, PA
GENERAL PLAN
APPROVED FOR THE DISTRICT ENGINEER
CORPS OF ENGINEERS U.S.A.
DATE NOVEMBER 1967
SCALE AS SHOWN
DRAWING NO 1

EXHIBIT 2-2

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7. SELECTED PLAN

Scheme Three was selected as the proposed plan of improvement. The following is a summary of estimated construction costs, including allowances for contingencies and engineering, for the four alternate Schemes investigated in detail.

Scheme One	$2,430,000
Scheme Two	$2,913,000
Scheme Three	$2,355,000
Scheme Four	Not Estimated - Not technically feasible

The construction costs of Schemes One, Two, and Three are about equal. The principal advantage of Scheme Three is that the improvements could be constructed without any disruption of community activity, while both Schemes One and Two would require traffic relocations, loss of business, disruption of water and sewerage service, along with the necessity for blasting in the downtown business district. In addition, Scheme Three would permit the discharge of Wabash Creek into Little Schuylkill River at a point below the business center and would obviate the need for approximately 1,000 feet of open channel within the Borough which would be required by Schemes One and Two.

8. DISCUSSION OF SELECTED PLAN

The proposed plan would meet the need for flood control on Wabash Creek. Other damage prevention needs at Tamaqua, such as flood control on Little Schuylkill River, will be met with the completion of four Soil Conservation Service dams located in the headwater regions of the Little Schuylkill River. When completed, it is estimated that the SCS reservoirs on the upper tributaries of Little Schuylkill River will provide protection from floods from that source with an approximate frequency of recurrence of once in 100-years. The proposed improvements were sized to provide comparable flood control on Wabash Creek. The present channel capacity of the Little Schuylkill River is adequate to pass the 100-year flood from Wabash Creek, Panther Creek, and the controlled discharges of the Schuylkill River at the same time.

Due to physical limitations of available construction methods, the minimum feasible diameter for tunnel construction is approximately eight feet. In order to provide flood protection to the affected area compatible with that on the Schuylkill River, a 10-foot diameter tunnel was selected as the recommended improvement. Structural features of this tunnel are described and illustrated in Paragraph 11. However, the incremental costs associated with an increase in tunnel diameter are relatively small. Therefore, it may be desirable to enlarge the tunnel size to accommodate a flood of standard project flood magnitude on Wabash Creek even though comparable flood protection would not be provided on the River. If the improvements proposed are subsequently authorized, more detailed consideration will be given to the possibility of constructing a larger sized tunnel prior to construction.

SECTION III - DESIGN CONSIDERATIONS

9. HYDROLOGIC

The four-reservoir flood control system on upper tributaries of Little Schuylkill River was planned by the SCS to eliminate flooding at Tamaqua from storms over that watershed of a magnitude up to and including the once in one hundred year event. Panther Creek has not been a serious flood problem in the past, and, with the completion of the SCS reservoirs upstream, it is expected to be less of one in the future. The Little Schuylkill River channel capacity at Tamaqua (10,000 cfs) is adequate to pass the 100-year flood, even assuming the most unlikely possibility that the controlled Little Schuylkill, and the uncontrolled Panther and Wabash Creeks all peak at the same time. In designing the proposed project, the existing conduit in Tamaqua is assumed to remain usable and capable of carrying the 100-year storm runoff from the residual drainage area of Wabash Creek below the tunnel portal. This is estimated to be about 250 cfs.

The following information, obtained from the SCS, shows discharges, both actual and estimated, for Little Schuylkill River at a USGS stream gage, located 0.6 miles upstream from the mouth of Wabash Creek at Tamaqua. The gage records the runoff from 42.9 square miles of drainage area. The discharges indicated are representative of conditions "before" and "after" construction of the four-reservoir flood control system on the upper tributaries of the Little Schuylkill River.

Flood	Discharge (cfs) Before Project Installation	Discharge (cfs) After Project Installation
18 August 1955	8,300	3,300
Estimated 100-year	11,000	4,450
Estimated 20-year	6,000	2,400
Estimated 5-year	2,800	1,160

The estimated 100-year flood discharge at the stream gage, after project installation, was used for this study. The peak discharge was increased by the ratio of the square root of the drainage areas to represent the discharge for the drainage area at the confluence of Wabash Creek and Little Schuylkill River which includes Panther Creek discharge.

The rating curve of Little Schuylkill River, representing a location 100 feet downstream of the confluence with Wabash Creek, was used to determine the maximum elevation of the water surface for the peak discharge of the 100-year flood in the Little Schuylkill River.

Wabash Creek drainage area is bounded on the north by Locust Mountain and on the south by Sharp Mountain, both of which are about 1,500 feet above sea level. Wabash Creek flows from west to east and discharges into the Little Schuylkill River, which flows in a north-to-south direction.

Wabash Creek is an ungaged stream and as such it was necessary to develop peak discharges by synthetic methods. The standard project flood was computed using the generalized methods prescribed in Civil Works Engineer Bulletin No. 52-8. The computed peak discharge was 2,200 cfs. The flow selected for comparison of the various schemes was 1,500 cfs, representing the flow from a storm having a one-percent chance of occurrence in any one year. After careful consideration of the characteristics of the watershed, the past history of flooding, and the physical necessities associated with tunnel construction (the diameter of the tunnel having a practical lower limit of eight feet), it was decided to provide protection up to, and including, the event having a frequency of occurrence of 1 percent in any year (peak discharge 1,500 cfs) by increasing the diameter to ten feet.

Preliminary hydraulic design and analyses were based on the assumption that the Wabash Creek watershed would peak well before the Little Schuylkill River and Panther Creek. Under these conditions, the stilling basin and sill are sized to produce a hydraulic jump. To test the design under the most adverse conditions, a flow of 7,500 cfs, representing the concurrent 100-year flows of Panther Creek and the controlled Little Schuylkill River, was assumed to occur at the same time that Wabash Creek discharges its peak flow. In the rare case where this would take place, the tailwater depth exceeds the sequent depth of the Wabash Creek flow and the hydraulic jump drowns, thereby causing the tunnel to prime and flow as a pressure conduit. While this situation is not desirable, in that the drowned jump will produce high velocities in the exit channel, it is considered that the extremely low probability of such an occurrence does not warrant channel protection measures greater than those provided.

10. GEOLOGIC

The proposed tunnel would be driven through Sharp Mountain. The axis of the anticline which forms Sharp Mountain bears approximately N 75°E, with the bedding planes dipping between 56° and 80° on both sides of the axis. The proposed tunnel would bear S 70°E, forming an angle of approximately 35° with the strike of the rock. Examination of existing mine shafts and tunnels in Sharp Mountain shows very few rock falls in unsupported shafts up to 28 feet in diameter.

Area and Site Geology - Sharp Mountain and Locust Mountain are part of the Appalachian Mountain range which is located north of the

Piedmont Plateau. The upper elevations of the mountains have been strip-mined of coal. The areas are unsightly because the thin mantle of top soil has been removed and only culm piles and open pits remain. Vegetation is unable to grow; this results in great quantities of silt being washed down the steep slopes and carried downstream by Wabash Creek's floodwaters.

Tamaqua is located north of the Blue Mountain section in the Valley and Ridge Province of the Appalachian Highlands. The Valley and Ridge Province is underlain by clastic rocks except for a narrow belt a few miles north of Blue Mountain which is underlain by carbonate rocks. The oldest clastic formation which is exposed is the Martinsburg shale of Ordovician Age. Clastic rocks include conglomerate, silt stone, sandstone, clay stone, shale and slate.

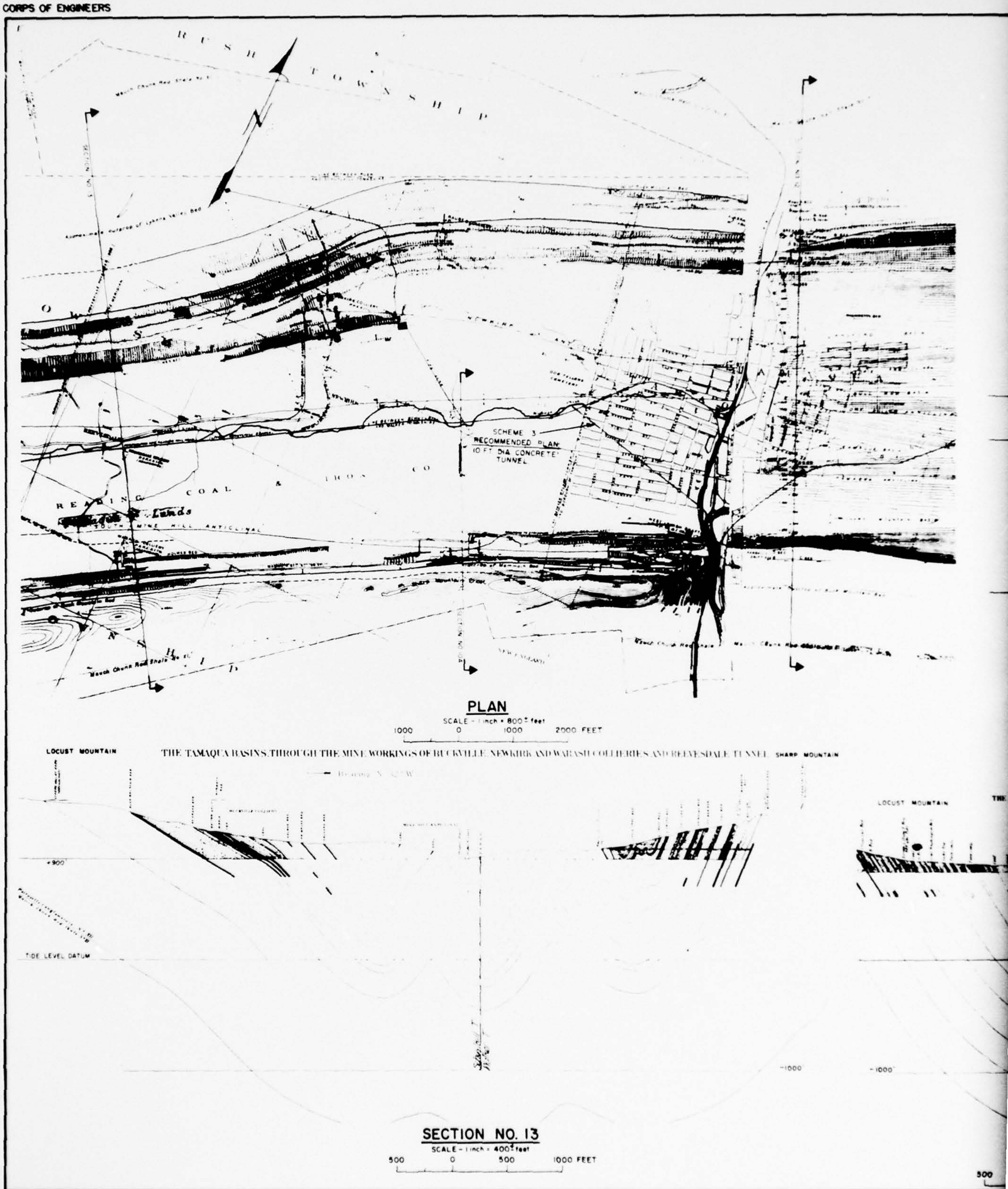
The Shawangunk conglomerate of Silurian Age lies on the surface of the Martinsburg shale and dips moderately to steeply northward to form the Blue Mountain ridge.

From the Shawangunk conglomerate upward, the formations of Silurian to Pennsylvanian Age are folded into a series of anticlines and synclines cut by numerous faults. A large portion of the material originally deposited has been eroded, and only the more resistant rocks of the anticlines and synclines remain. The harder beds of sandstone and conglomerate form ridges which rise as much as 2,000 feet above sea level. The softer beds of shale, along with some limestone, form the intervening valleys.

The Allegheny formation, found within the alternating layers of coarse-to-fine-grained sandstone, shale, silt stone, clay stone and conglomerate, is a coal-bearing sequence containing irregular beds that range from shale and fire clay to coarse-grained sandstone and conglomerate. This coal has been the basis of economic development in the past, but the inroad of competing fuels and depletion of good available stripping reserves has been a major reason for economic decline of the area.

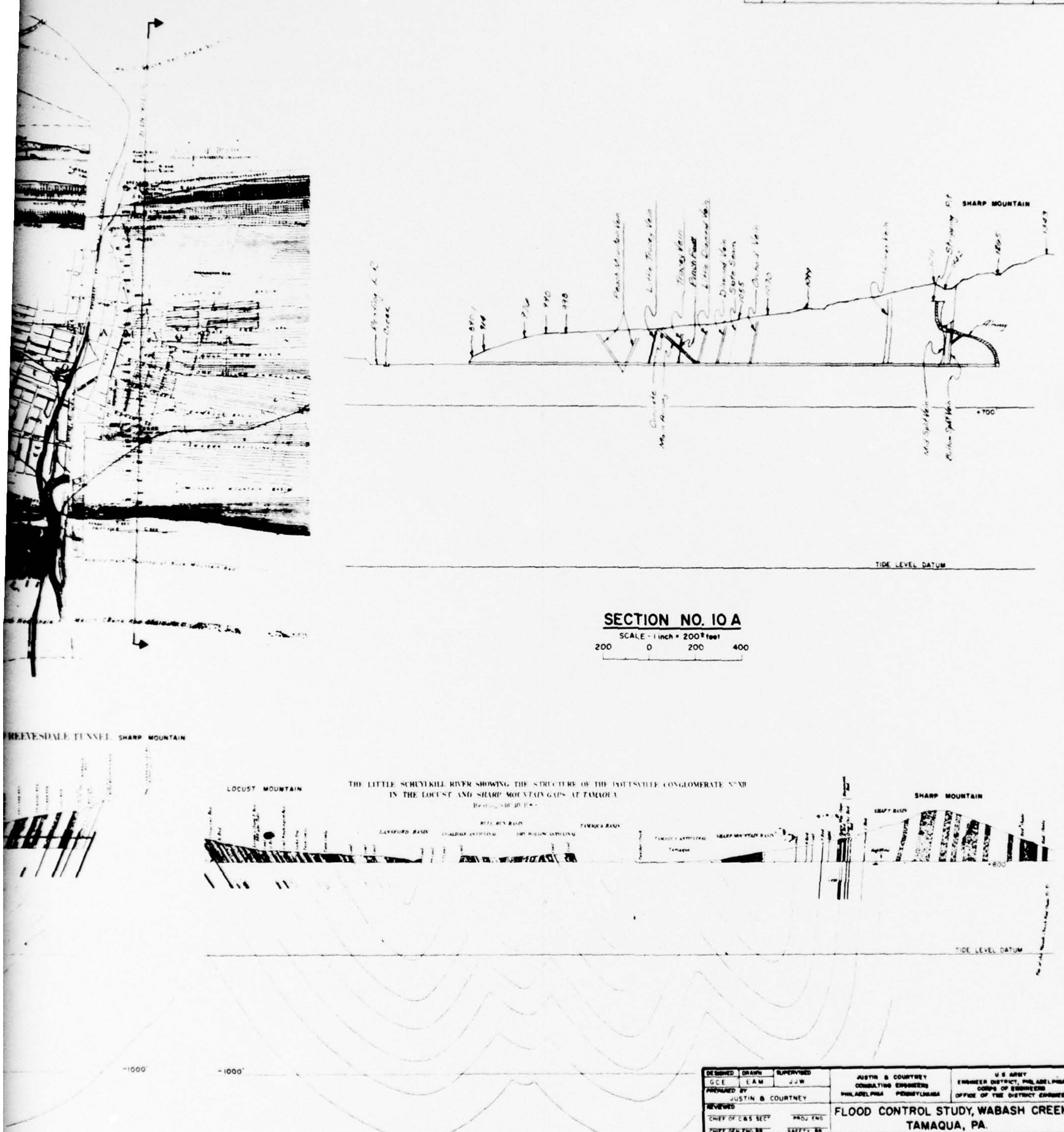
Exhibit 2-3 is a general plan showing the extent of deep mining in the Locust-to-Sharp Mountain area. As indicated, the mining was very extensive and many of these mines have been abandoned. Much of the deep mining used equipment available in the late 1800's and early 1900's. As the mines became more extensive in area and penetrated further into the mountains, costs of mining began to increase. After the early 1900's more modern equipment became available which was capable of handling far greater volumes of materials than previously. These machines were capable of stripping huge quantities of overburden to reach the coal beds. Thus, strip mining became a reality.

CORPS OF ENGINEERS



US ARMY

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPD



SECTION NO. 10 A

SCALE - 1 inch = 200± feet

200 0 200 400

SECTION NO. 12

SCALE - 1 inch = 400± feet

500 0 500 1000 FEET

DESIGNED	DRAWN	SUPERVISED	JUSTIN & COURTNEY CONSULTING ENGINEERS PHILADELPHIA PENNSYLVANIA	U S ARMY ENGINEER DISTRICT, PHILADELPHIA CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER
GCE	EAM	JJW		
PREPARED BY JUSTIN & COURTNEY				
REVIEWED CHIEF OF C&S SECT PROJ ENG CHIEF GEN ENG BR SAFETY BR			FLOOD CONTROL STUDY, WABASH CREEK TAMAQUA, PA.	
SUBMITTED CHIEF DESIGN BRANCH			PLAN OF MINE WORKINGS AND GEOLOGIC SECTIONS	
RECOMMENDED CHIEF ENGINEERING BRANCH				
APPROVED FOR THE DISTRICT ENGINEER CORPS OF ENGINEERS U.S.A.			SIZE F INV NO CIVENG 90-100	DRAWING NO 5
DATE NOVEMBER 1967			SCALE AS SHOWN	SHEET

EXHIBIT 2-3

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Exhibit 2-3 shows generally the geologic profile as reproduced from early maps made by coal company geologists and mining engineers. Section 13 shows the syncline between Locust Mountain and Sharp Mountain with the Pottsville Conglomerate No. XII series of the Alleghany formation overlying the Mauch Chunk Red Shale No. XI.

Resources Affected - Mineral rights in the Tamaqua area are primarily coal rights, the boundaries of which are established by coal tracts. The tracts have two distinct spheres of importance: one, coal reserve, or coal located beneath the surface of the ground; and two, surface coal. The tracts have been subdivided over the years and are now owned by private companies, by the Tamaqua area joint school system, and by the Schuylkill County Commissioners.

An estimated 1,700 tons of coal will be part of the tunnel excavation. Cost for the coal in the reserve and for surface coal has been estimated as a lump sum item.

Further Investigations - To arrive at final detailed designs and an attendant cost estimate will require that additional test borings be made at the inlet channel, tunnel entrance portal, tunnel exit portal, and stilling basin area.

Strip mine pits are located in the mountains of the Wabash Creek watershed. Some abandoned pits act as detention basins for surface runoff discharge into mine shafts and tunnels. A study of these pits as storage areas, and the associated problem of accidental release of water, should be made to ascertain effects on the potential flood project at Tamaqua.

11. STRUCTURAL

The tunnel plan shown as Scheme 3, Plan and Profile, on exhibit 2-4 is the most economical plan in comparison to others studied. It has the minimum permanent right-of-way requirements, and would have the least effect on community activities during construction. In addition, the tunnel would be relatively maintenance free except for removal of silt depositions in the stilling basin located at the exit of the tunnel.

The outlet channel would be located to maintain a minimum 45 degree angle between the tunnel centerline and the railroad tracks in order to comply with the Reading Company's regulations. The outlet channel would discharge directly into Little Schuylkill River. If the outlet channel were relocated to the south, the angle between tunnel and tracks would decrease to less than 45 degrees, and the increased length of the tunnel would increase the construction cost. Relocating the outlet channel to the north would create hydraulic design problems and would cause it to discharge into the existing Wabash Creek channel rather than Little Schuylkill River. The tunnel would also have less rock cover.

Detailed Description - The 10-foot wide inlet channel, with a slope of 0.001 would be 260 feet long and would extend from Wabash Creek to the intake control section at the tunnel entrance portal. Shallow excavation of one to two feet would be required for the channel. A dike approximately 10 feet high would be constructed to elevation 841.5 on the east side of the inlet channel to train all Wabash Creek flows into the tunnel intake. The approach to the tunnel intake control structure would be protected with 18-inch thick riprap placed on a 6-inch thick filter bed for a length of 50 feet. Downstream of the riprap a reinforced concrete slab would protect the approach channel and intake structure against scouring and undermining. The intake structure shown on exhibit 2-5, Scheme 3, "Inlet Plan and Sections", would form a transition and make a 10-foot drop from a 14-foot wide rectangular control section to a 10-foot diameter circular section. Rock outcrops are visible on the hillside some distance from the tunnel intake location; however, rock bolts or steel ribs may be required for an undetermined distance into the hillside.

Due to the highly acid character of the waters of Wabash Creek during low and normal flow conditions, it was considered necessary to provide the concrete slab, the intake structure, and the bottom half of the tunnel with a protective lining. Vitreous clay was chosen over alternate materials such as asphalt, epoxy, asbestos cement, and stainless steel as being the most economical and suitable material available with proven abrasion and acid resistant characteristics.

The tunnel would have a minimum unlined diameter of 13 feet and a 6-inch overbreak allowance. The neat lined diameter would be 10 feet and constructed on a slope of 0.0147 through the mountain. Vitreous clay lining would be provided for 180^{o} of its circumference. Structural steel lagging has been assumed for 2,000 feet of its 2,930 feet. The 2,930 feet includes the railroad box culvert.

Tunnel excavation would stop west of the railroad tracks. The area between the tracks and the mountain would be excavated by open trench method rather than tunneling. A transition from the 10-foot diameter tunnel section to a 10-foot square section would be made beneath the railroad tracks.

The method of underpinning the railroad tracks which is approved by the Reading Company is shown on exhibit 2-6, Scheme 3, "Outlet Plan and Sections". The underpinning consists of stringering the tracks for foundation excavation. Sheeting would be driven on all sides of the material to be excavated. Concrete walls would be constructed between the sheeting after the soil is excavated. Atop the concrete walls and bearing on sole and masonry plates, heavy wide flange steel beams with appropriate diaphragms would be placed under each rail. Ties, 10 inches by 10 inches in section and 10 feet long, would be placed between the wide flange sections and the rails. Walkways and

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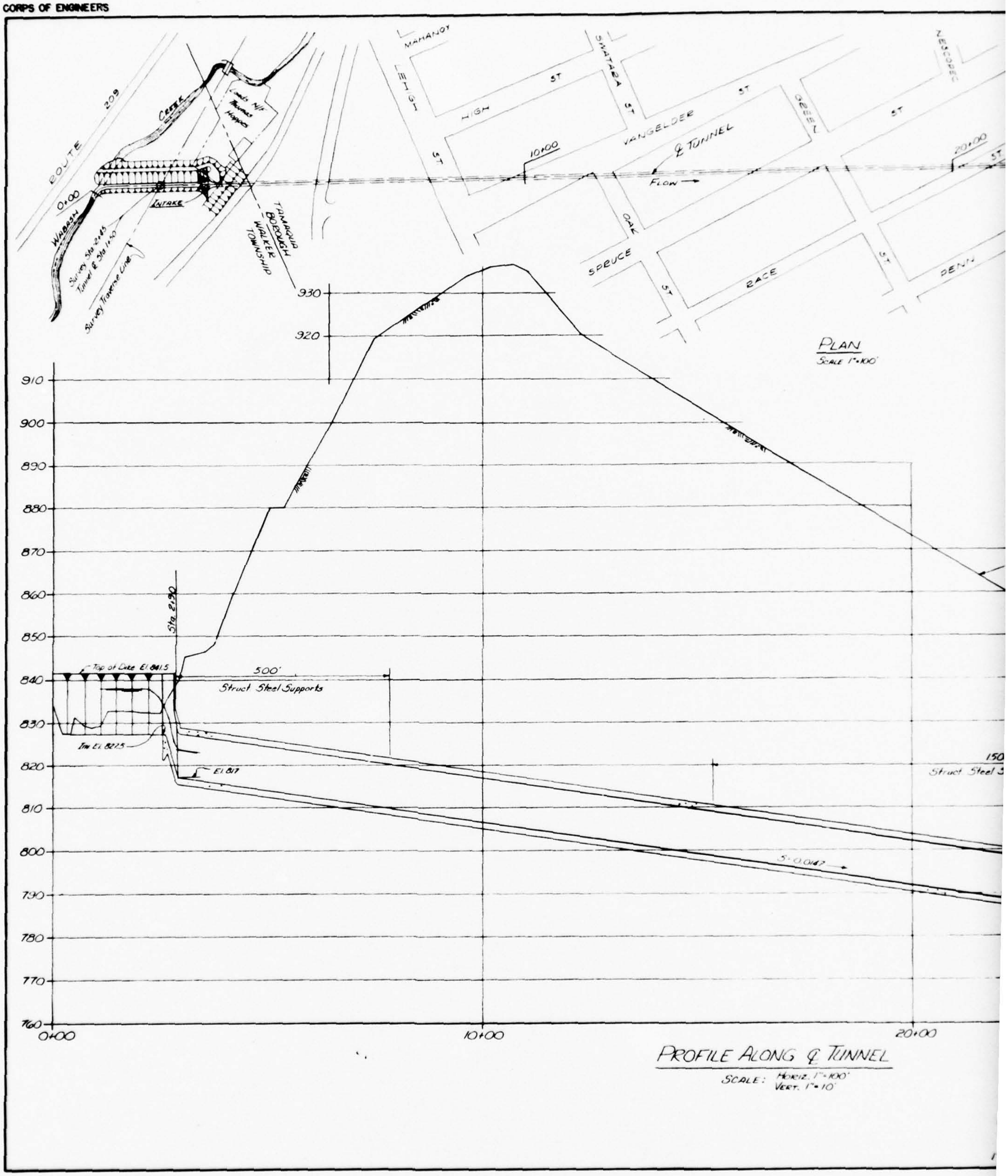


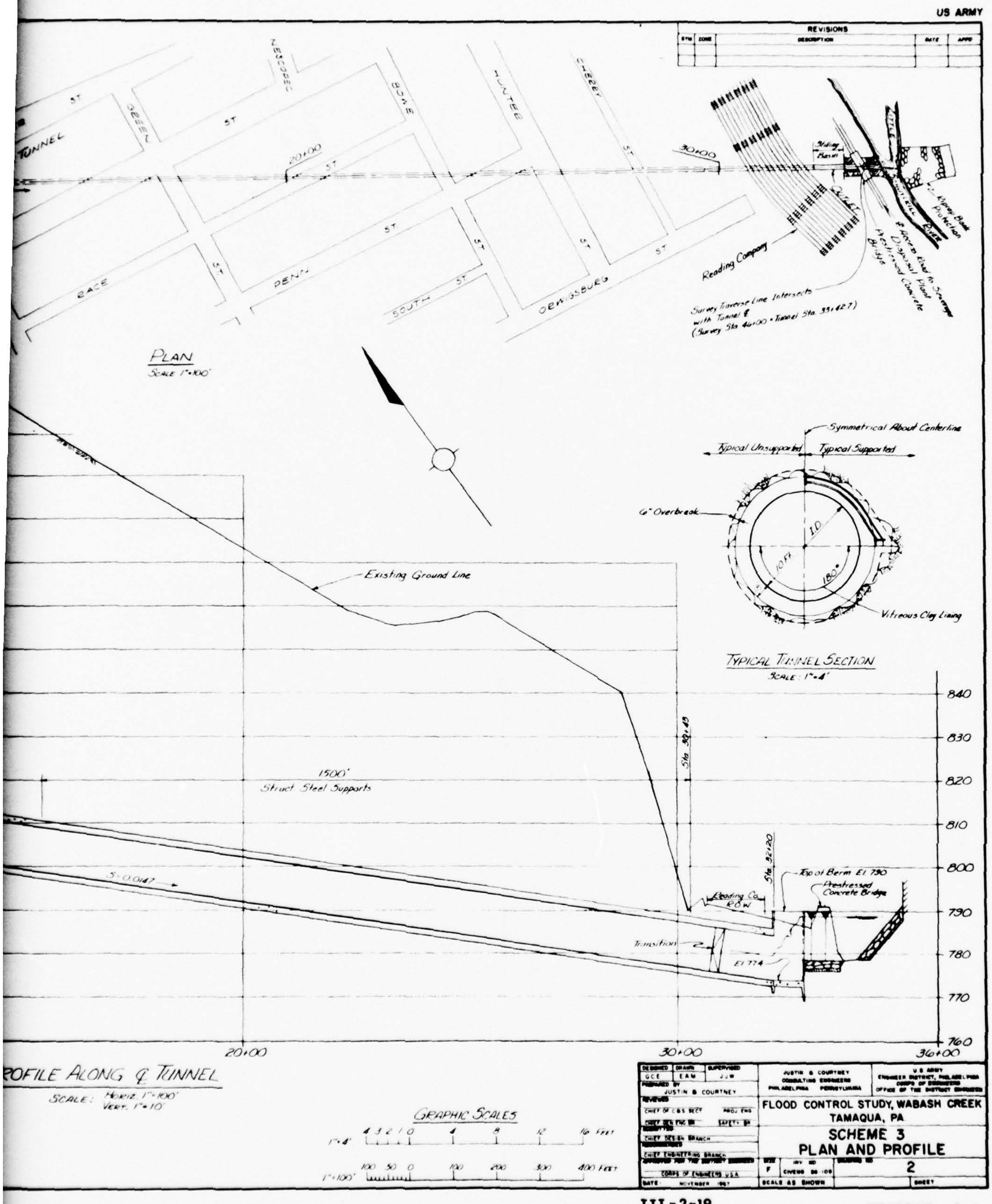
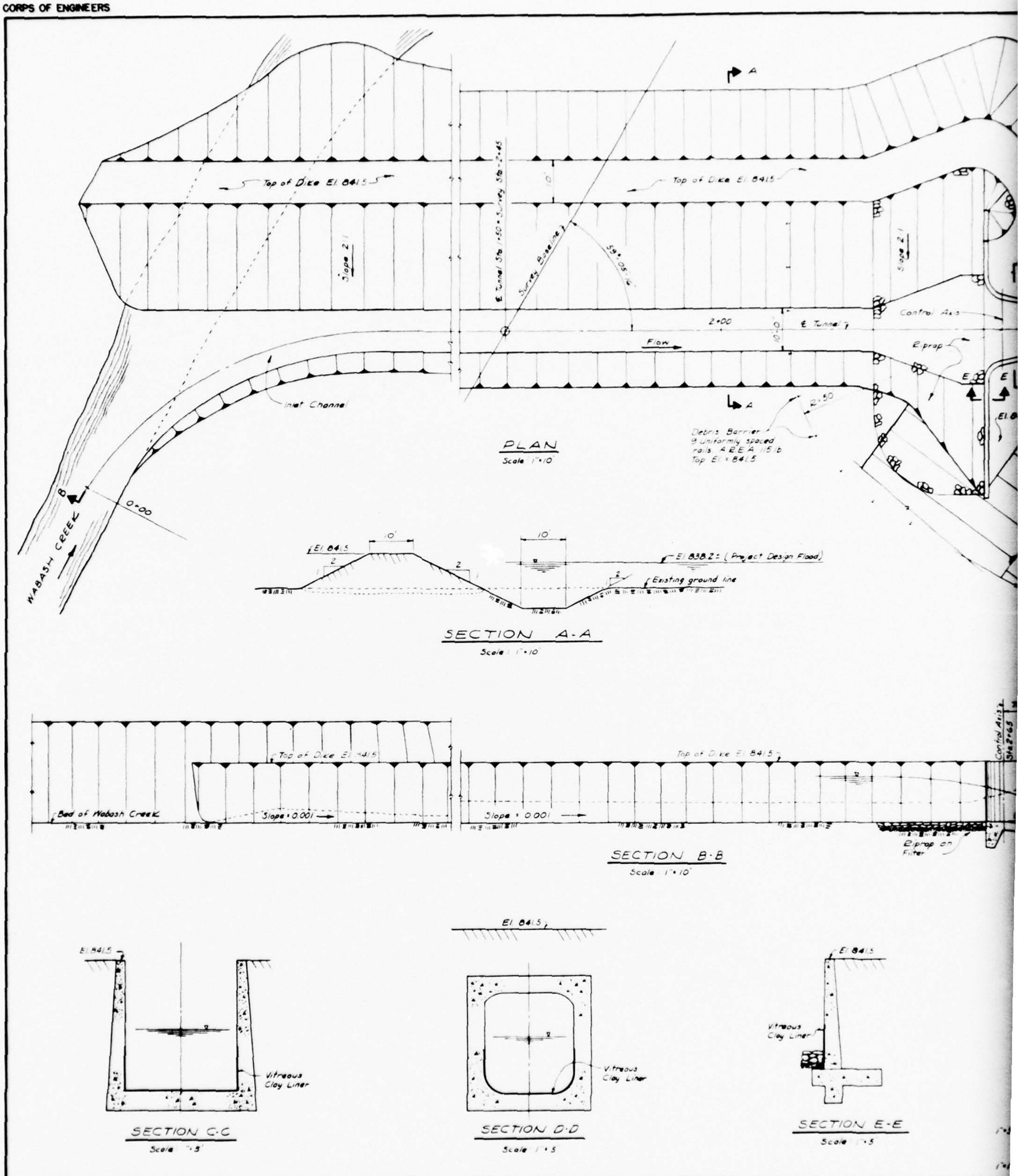
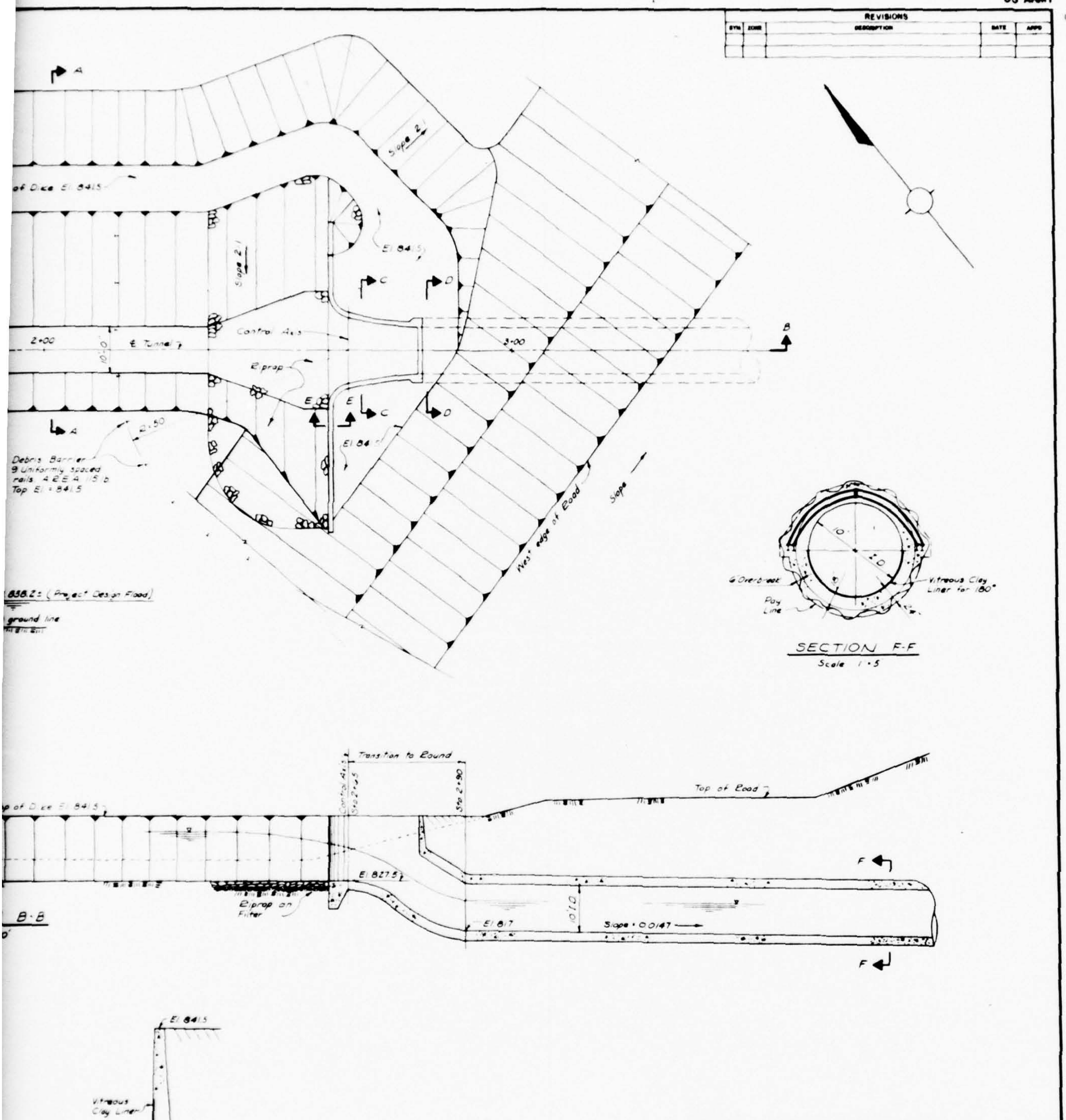

US ARMY
REVISIONS
TUNNEL
GREEN ST
NESCOPEC
BURK
HUNTER
CHERRY ST
20+00
30+00
ST
RACE
PENN ST
SOUTH ST
ORWIGSBURG
Reading Company
Stilling Basin
Outlet
Little Schuylkill River
Riprap Bank Protection
Prestressed Concrete Bridge
Survey Traverse Line Intersects with Tunnel ℄ (Survey Sta. 46+00 = Tunnel Sta. 33+42.7)
PLAN
SCALE 1"=100'
Symmetrical About Centerline
Typical Unsupported
Typical Supported
6" Overbreak
10 Ft
180°
Vitreous Clay Lining
TYPICAL TUNNEL SECTION
SCALE: 1"=4'
Existing Ground Line
1500'
Struct. Steel Supports
Sta. 30+49
Sta. 32+20
Top of Berm El. 790
Prestressed Concrete Bridge
Reading Co. R.O.W.
S=0.0147
Transition
El 774
840
830
820
810
800
790
780
770
760
20+00
30+00
36+00
PROFILE ALONG ℄ TUNNEL
SCALE: Horiz. 1"=100' Vert. 1"=10'
GRAPHIC SCALES
1"=4'
4 3 2 1 0 4 8 12 16 FEET
1"=100'
100 50 0 100 200 300 400 FEET
DESIGNED GCE
DRAWN EAM
SUPERVISED JJW
PREPARED BY JUSTIN & COURTNEY
JUSTIN & COURTNEY CONSULTING ENGINEERS PHILADELPHIA PENNSYLVANIA
U.S. ARMY ENGINEER DISTRICT, PHILADELPHIA CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER
FLOOD CONTROL STUDY, WABASH CREEK
TAMAQUA, PA
SCHEME 3
PLAN AND PROFILE
CORPS OF ENGINEERS U.S.A.
DATE: NOVEMBER 1967
SCALE AS SHOWN
2

EXHIBIT 2-4

CORPS OF ENGINEERS



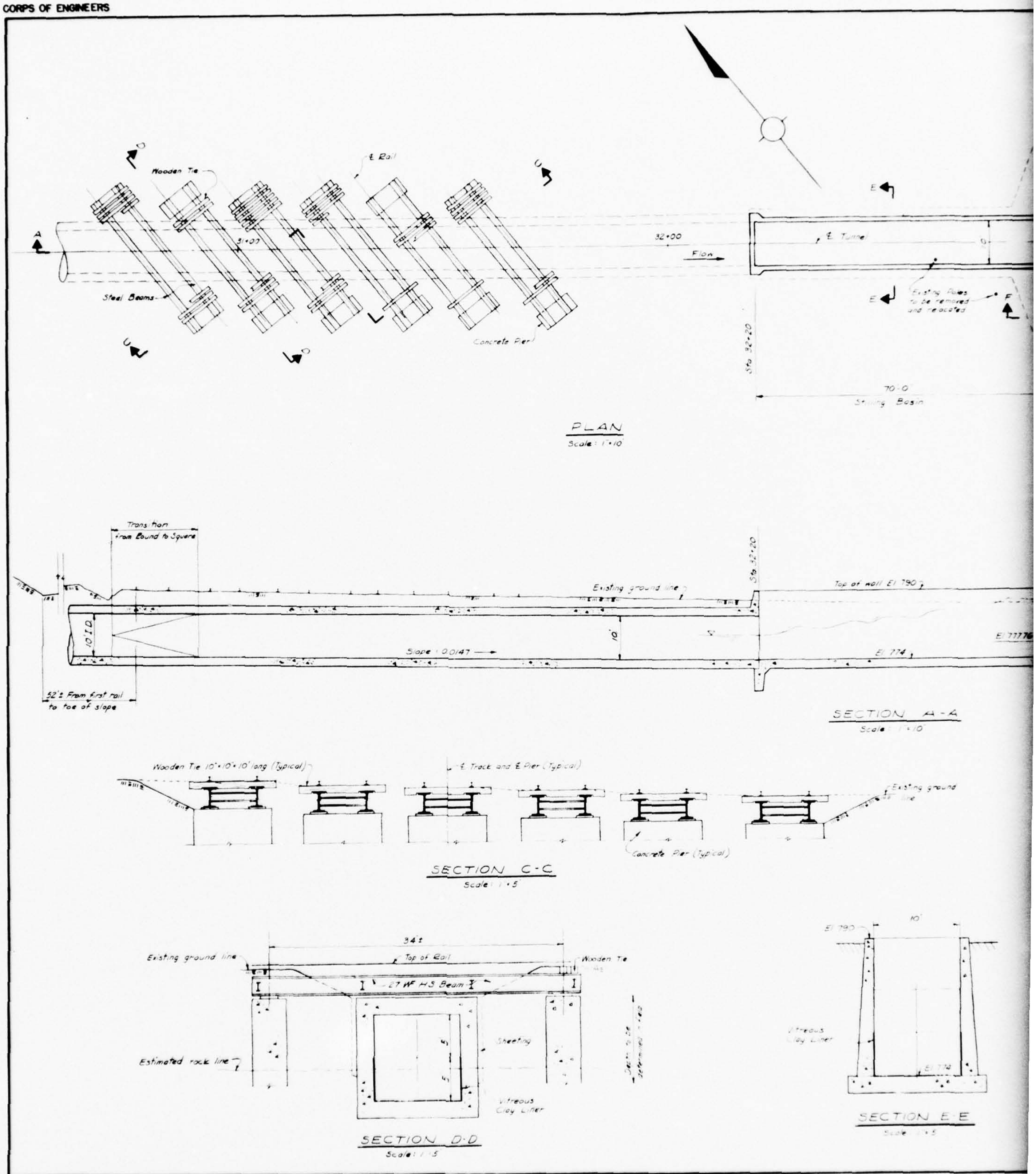
US ARMY



DESIGNED GCE / DRAWN EAM / SUPERVISED JJW; PREPARED BY JUSTIN & COURTNEY	JUSTIN & COURTNEY CONSULTING ENGINEERS PHILADELPHIA PENNSYLVANIA	U.S. ARMY ENGINEER DISTRICT, PHILADELPHIA CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER
REVIEWED: CHIEF OF C.B.E. SECT. / PROJ. ENG.	FLOOD CONTROL STUDY, WABASH CREEK TAMAQUA, PA.	
CHIEF DES. ENG. BR. / SAFETY BR.	SCHEME 3	
SUBMITTED: CHIEF DESIGN BRANCH	INLET PLAN AND SECTIONS	
RECOMMENDED: CHIEF ENGINEERING BRANCH		
APPROVED FOR THE DISTRICT ENGINEER: CORPS OF ENGINEERS U.S.A.	SIZE F; INV. NO. CIVENG 56-109; DRAWING NO. 3	
DATE: NOVEMBER 1967	SCALE AS SHOWN	SHEET

EXHIBIT 2-5

CORPS OF ENGINEERS



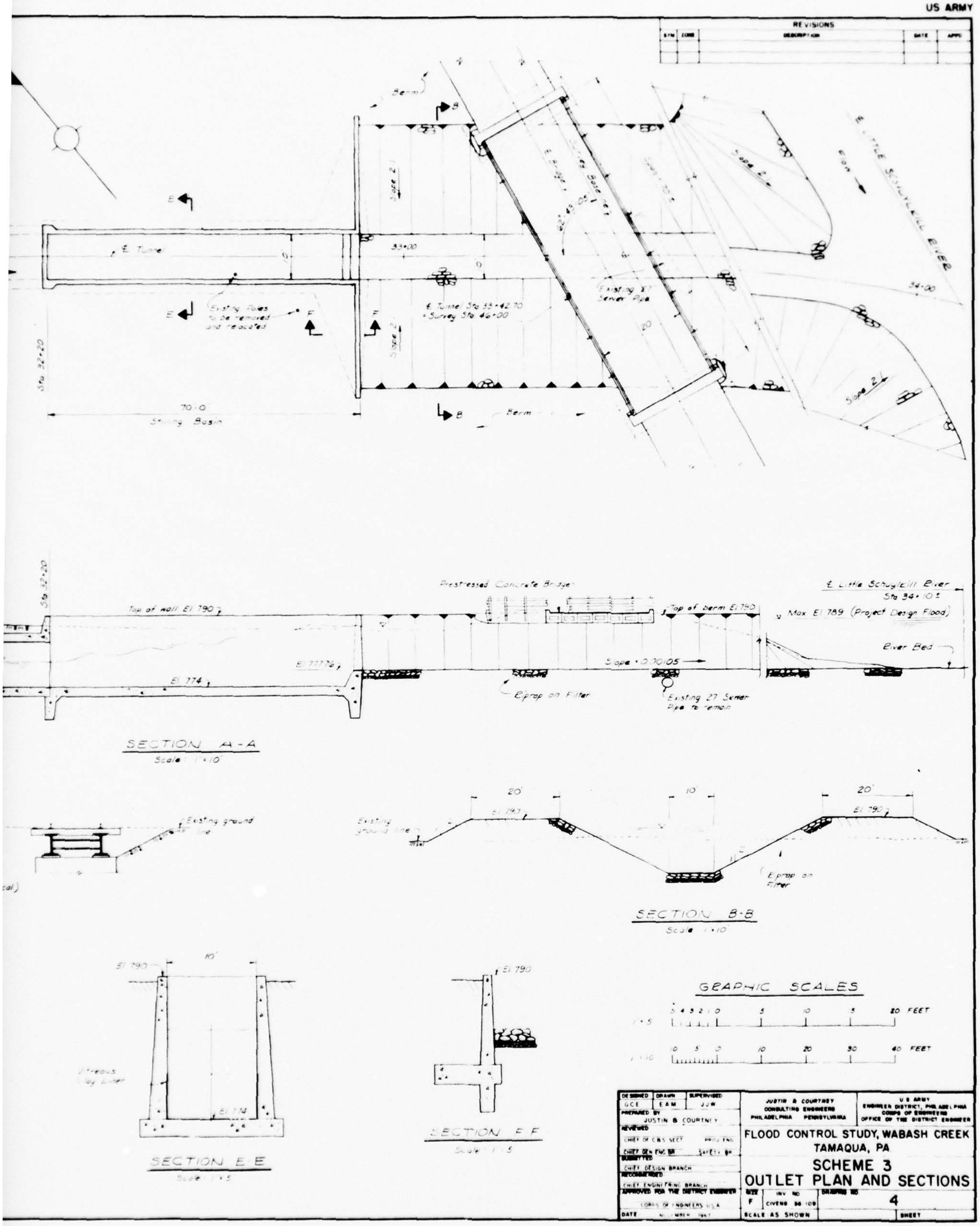

US ARMY
REVISIONS
SYM ZONE DESCRIPTION DATE APPR
Berm
B
E
℄ Tunnel
33+00
Existing Poles to be removed and relocated
F
℄ Tunnel Sta 33+42.70 = Survey Sta 46+00
Existing 27" Sewer Pipe
Slope 2:1
Sta 32+20
70'-0"
Stilling Basin
Berm
℄ Little Schuylkill River
Flow
34+00
Prestressed Concrete Bridge
Top of wall El 790
Top of berm El 790
℄ Little Schuylkill River Sta 34+10 ±
Max El 789 (Project Design Flood)
River Bed
El 777.76
El 774
Slope = 0.00105
Riprap on Filter
Existing 27" Sewer Pipe to remain
SECTION A-A
Scale 1"=10'
Existing ground line
20'
10'
20'
El 790
Existing ground line
Riprap on Filter
SECTION B-B
Scale 1"=10'
El 790
10'
El 774
Vitreous Clay Liner
SECTION E-E
Scale 1"=5'
El 790
SECTION F-F
Scale 1"=5'
GRAPHIC SCALES
1"=5' 5 4 3 2 1 0 5 10 15 20 FEET
1"=10' 10 5 0 10 20 30 40 FEET
DESIGNED GCE DRAWN EAM SUPERVISED JJW
PREPARED BY JUSTIN & COURTNEY
JUSTIN & COURTNEY CONSULTING ENGINEERS PHILADELPHIA PENNSYLVANIA
U S ARMY ENGINEER DISTRICT, PHILADELPHIA CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER
FLOOD CONTROL STUDY, WABASH CREEK
TAMAQUA, PA
SCHEME 3
OUTLET PLAN AND SECTIONS
DRAWING NO 4
SCALE AS SHOWN

EXHIBIT 2-6

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railings, if required, may be constructed on longer ties. After all the six tracks have been supported, the excavation for the box culvert beneath the tracks could be accomplished with relative ease within the regulations prescribed by the Reading Company. Vitreous clay lining would be installed on the invert and to a height of 5 feet on the walls of the box culvert.

Downstream or east of the tracks a 10-foot wide by 70-foot long reinforced concrete stilling basin would be constructed. The stilling basin would be lined with vitreous clay similar to the box culvert. Downstream of the stilling basin, a 10-foot wide outlet channel would be constructed on a slope of 0.001 for 100 feet to Little Schuylkill River.

A single 70-foot span prestressed concrete bridge would be constructed about 50 feet upstream of Little Schuylkill River. The bridge would be 20 feet wide, would provide access to the sanitary disposal plant and access for future industrial development traffic from Spruce Street. The outlet channel would be constructed on a 700-foot radius (8^{o} curve) between the bridge and the river.

The Borough's sanitary interceptor system consists of a 27-inch diameter concrete pipe laid below the existing paved road where the prestressed concrete bridge and outlet channel would be constructed. Special provisions would be necessary to insure the integrity of this line during and after construction.

A 10-inch drain in the vicinity of the outlet channel would require headwalls in the channel prism so that drainage would go directly into the channel.

The inlet and outlet structures, bridge and stilling basin will be designed, constructed and lanscaped to present attractive structures and surroundings. Contingency allowances (see Tables 2-1 and 2-3) are considered adequate to permit beautification measures.

12. RELOCATIONS

No relocations other than temporary diversion of railroad traffic from one existing track to another on the same right-of-way will be required. Existing access to the reaches of the valley above the diversion dike will not be affected by project construction.

13. REAL ESTATE

The tunnel alignment was selected on the basis of the shortest possible route with the minimum right-of-way requirements. The inlet channel and entrance portal would be located on undeveloped land,

abandoned railroad property, and Hoppes Lumber Company property. The lumber company does not appear to be actively using the land required to be taken. Land now occupied by Wabash Creek downstream of the tunnel entrance portal could be utilized by the lumber company, particularly in the area where the offices, store and wood working retail shops are located. Relocating the tunnel entrance westward would increase the construction cost by increasing the tunnel length. Relocating the tunnel entrance eastward would seriously limit the lumber company's operations, or make acquisition of the total property necessary. If necessary, the entrance portal on the upstream end of the tunnel could be relocated on the southeast side of the private road and a bridge constructed across the inlet channel for the road incised by the channel.

Right-of-way - In addition to the 1.8 acres of right-of-way and land acquisition required for entrance and exit portals, it will be necessary to acquire the mineral rights to portions of coal tracts. Acquisition of these tracts will prevent mining that would endanger the structural integrity of the tunnel. The tunnel would traverse coal tracts owned by the Tamaqua area joint school system and the Schuylkill County Commissioners. There is one non-public owner from whom mineral rights would have to be purchased.

14. RECREATION

Inclusion of recreation as a project purpose was not feasible because of the scheme selected and the low pH (2.9 - 3.0) of the water in Wabash Creek. The stream does not presently support fishing or any other form of water-related outdoor recreation.

SECTION IV - COST ESTIMATES

15. PROJECT COST

Summaries of first cost and financial annual cost are shown in tables 2-1 and 2-2, respectively. A detailed estimate of first cost is presented in table 2-3. A general plan of the proposed project is illustrated in Scheme 3 on exhibit 2-2.

First Cost - The estimated first cost of the tunnel scheme, including government and land acquisition costs, is $2,355,000.

Annual Charges - Annual charges were computed using an interest rate of 3¼ percent and an amortization period of 100 years. The 100-year amortization period was selected after analysis of the lives of the component structures of the protection scheme. The useful lives were taken from "Income Tax Depreciation and Obsolescence, Estimated Useful Lives and Depreciation Rates, U.S. Bureau of Internal Revenue Bulletin F, 1942."

Cost of Maintenance - Operation and maintenance of the project will be the responsibility of the local interests. Work will consist of periodic cleaning of the stilling basin, cleaning of the entrance and exit channels, mowing and minor repairs. If an orderly plan for this work is scheduled and the schedule maintained, it is estimated that maintenance will cost approximately $2,000 annually.

TABLE 2-1
SUMMARY OF FIRST COST

Federal Costs			
Intake Channel			$ 33,960
Tunnel			1,231,840
Outlet Channel			243,150
Subtotal			1,508,950
Contingencies (25%)			377,250
Subtotal			1,886,200
Engineering and Design (Incl S & A)			392,490
Total Federal Costs			$2,278,690
Non-Federal Costs	Quantity	Unit Cost	Total Cost
Right-of-Way	1.8 Ac.	$5,000	$ 9,000
Mineral Rights	L.S.		10,000
Bridge & Approaches	1,400 S.F.	30	42,000
Subtotal			61,000
Contingencies (25%)			15,250
Total Non-Federal Costs			$ 76,250
Total Project Cost			$2,355,000

TABLE 2-2
SUMMARY OF ANNUAL COST

Federal Annual Charges	
Federal First Cost	$2,278,690
Interest and Amortization	77,208
Total Federal Annual Charges	$ 77,208
Non-Federal Annual Charges	
Non-Federal First Cost	$ 76,250
Interest and Amortization	2,583
Annual Maintenance	2,000
Total Non-Federal Annual Charges	4,583

TABLE 2-2
SUMMARY OF ANNUAL COST
(CONT'D)

TOTALS		
Interest and Amorization	$	79,800
Maintenance		2,000
Total Annual Costs		81,800
Total Annual Costs (Rounded)	$	82,000

TABLE 2-3
DETAILED ESTIMATE OF FIRST COST

Item Description	Unit	Quantity	Unit Cost	Total Cost
Intake Channel				
Excavation (Common)	CY	740	$1.50	$1,110
Excavation (Structural)	CY	500	2.90	1,450
Backfill and Dike	CY	2,160	1.00	2,610
Riprap and Filter	SY	225	4.00	900
Concrete	CY	195	100.00	19,500
Reinforcing Steel	Lbs.	39,000	0.16	6,240
Vitreous Clay Lining	SF	900	2.40	2,160
Tunnel				
Excavation	CY	16,000	33.00	528,000
Concrete	CY	8,000	55.00	440,000
Structural Steel	Lbs.	354,000	0.25	88,500
Reinforcing Steel	Lbs.	276,000	0.16	44,160
Vitreous Clay Lining	SF	43,000	2.40	103,200
Grouting Concrete Lining	LF	2,750	10.00	27,500
Outlet Channel (including RR Underpinning)				
Excavation (Common)	CY	1,780	1.50	2,670
Excavation (Structural)	CY	2,600	2.90	7,540
Backfill and Dike	CY	2,000	1.00	2,000
Box Culvert Under RR	LS			130,000
Riprap and Filter (channel)	SY	730	4.00	2,920
(river)	SY	1,430	4.00	5,800

TABLE 2-3
DETAILED ESTIMATE OF FIRST COST
(CONT'D)

Item Description	Unit	Quantity	Unit Cost	Total Cost
Outlet Channel (including RR Underpinning) (Cont'd)				
Concrete	CY	463	100.00	46,300
Reinforcing Steel	Lbs.	92,500	0.16	14,800
Bridge	SF	1,400	30.00	42,000
Vitreous Clay Lining	SF	2,550	2.40	6,120
Utilities	LS			10,000
Miscellaneous				
Nat. Park Service Survey	LS			200
R.O.W.	AC	1.8	5,000	9,000
Mineral Rights	LS			10,000
Diversion & Pumping	LS			15,000
SUBTOTAL				$1,570,160
Contingencies (25%)				392,540
SUBTOTAL				$1,962,700
Engineering and Design (Incl S & A)				392,540
TOTAL (nearest $1,000)				$2,355,000

16. DEVELOPMENT COST

Development cost necessary to produce expansion benefits are as follows:

Urban Renewal and Community Owned Buildings	$1,500,000
Office Buildings (90,000 sq. ft.)	900,000
Stores and Other Commercial Structures (130,000 sq. ft.)	1,950,000
Financial Investment to Start and Operate New Businesses	850,000
	$5,200,000

Annual charges connected with the development costs indicated above equal $287,000. This amount has been discounted to reflect a 5-year development period.

Interest and Amortization = 5,200,000 X .03388		$176,000
Operation and Maintenance = 5,200,000 X .025		130,000
		$306,000
Adjustment for 5-year developmental period (0.9364)		287,000

Annual charges for the water project and the developmental plan would equal $369,000.

SECTION V - BENEFITS

17. SUMMARY OF BENEFITS

A summary of benefits accruing to the proposed plan of development for Tamaqua is presented in table 2-4.

TABLE 2-4
SUMMARY OF BENEFITS

Category & Class of Benefits	National Account Only	Regional Account Only	National & Regional Account	Total National Account	Total Regional Account
User Benefit					
Flood Control	--	--	$127,000	$127,000	$127,000
Expansion Benefits					
Development	--	$436,000	$287,000	$287,000	$723,000
Redevelopment	--	13,000	11,000	11,000	24,000
Total Expansion Benefits	--	$449,000	$298,000	$298,000	$747,000

18. USER

The proposed improvements would protect the damage-susceptible acreage in the Tamaqua study area from all Wabash Creek floods up to and including the event having a recurrence probability of one percent in any year.

Damage studies, including field level surveys to establish actual elevations of previous flooding, were conducted, along with interviews of property owners, public officials and commercial and utility interests who had experienced flood damage.

Flood damages were classified by type: residential, commercial-utility and public. The estimated tangible damages to be expected from an occurrence of a flood equal in magnitude to that of August 1955, which was a flood with an estimated frequency of recurrence of approximately 50 years, at the level of development existing in 1967 and without the plan of improvement under consideration are as follows:

Type of Damage	Amount of Damage
Residential	$ 46,600
Commercial-Utility	464,800
Public	15,000
Total Physical & Business	$526,400

Studies to correlate stages, damages and frequencies of flooding were conducted to develop the average annual damages associated with flooding of Wabash Creek. Based on actual damages sustained during the flood of record (18 August 1955), those studies indicated an average annual damage of $95,200 attributable to Wabash Creek under existing conditions, for a flood of this magnitude. Since the rainfall associated with 18 August 1955 storm was somewhat less than that used for the project design (100 year) storm, average annual damages under existing conditions, which would be prevented by the proposed project, are $95,200. Although further benefits from prevention of residual damages (associated with storms of greater magnitude than the design storm) may be attributed to the proposed project if detailed design is authorized, none are claimed at this time.

The average annual damages which would be prevented by the proposed project are summarized below. The residential damages are shown for two areas: Area I being the area which will remain residential, and Area II being the area which is presently residential, but was recently rezoned commercial. See Exhibit 2-7.

AVERAGE ANNUAL PREVENTABLE DAMAGES

(a) Residential	
1. Area I	$ 8,900
2. Area II (recently rezoned commercial)	4,500
Total Residential	13,400
(b) Commercial-Utility	78,900
(c) Public	2,900
Total Average Annual Preventable Damages	$ 95,200

The $95,200 is based on the present level of development; however, future levels of development must be taken into consideration in determining the average annual benefits over the life of the proposed

project. Although the land subject to flooding is developed, damages in excess of the present level will occur due to the rezoning of residential Area II for commercial use. This rezoning will increase the commercial area subject to flood by 50 percent.

It is considered that some commercial development will take place with or without the project as there is a paucity of land for development, and consistent increases in wholesale and retail trade are expected to produce expansion of facilities to meet the increased demand.

In order to evaluate the damages that will occur with residential Area II rezoned and developed commercially, the following assumptions were made:

(a) New commercial development, without the proposed project, would be an extension of the existing type of commercial development.

(b) New commercial development, with the proposed project in place, would consist of a greater utilization of Area II by allowing higher type commercial development than a mere extension of the existing uses. This development is analyzed in paragraph 19, below, entitled EXPANSION.

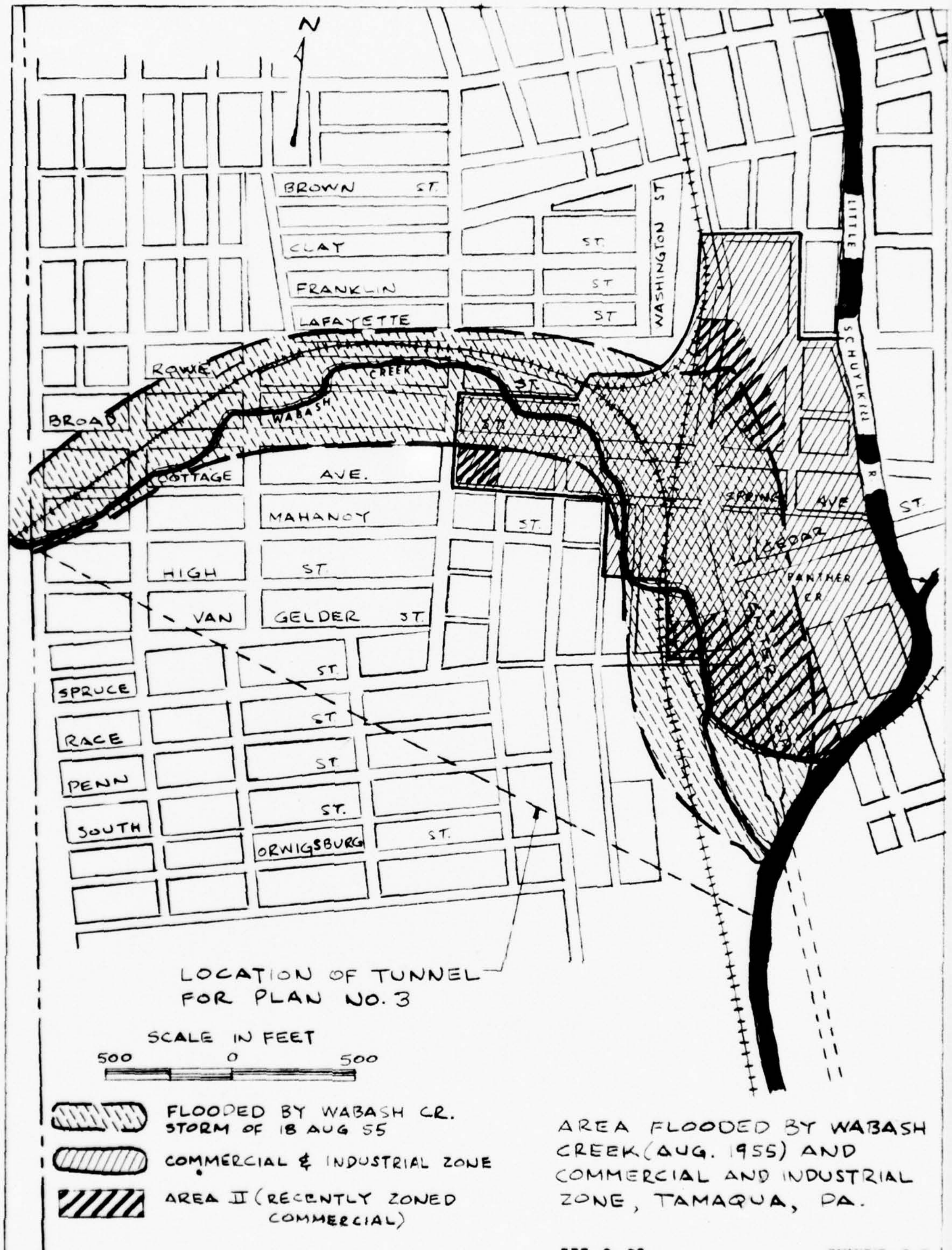
(c) The commercial development would take place in an accelerated manner and be complete in 50 years.

(d) Residential damages in rezoned (residential) Area II lose significance rapidly and should be netted out.

Based on these assumptions, the damages that would be prevented by the proposed project, and thus the benefits attributable to it, were computed as follows:

COMPUTATION OF BENEFITS

a. Project Life	100 years
b. Time to complete commercial development of residential Area II	50 years
c. Interest rate	3.25%
d. Average Annual Equivalent Factor (Associated with future prevented damages)	.758
e. Present Average Annual Damages	
1. Residential	
(a) Area I	$ 8,900
(b) Area II (to be developed commercially)	4,500
	$13,400
2. Commercial-Utility	78,900
3. Public	2,900
Total Existing Damages	$95,200



AREA FLOODED BY WABASH CREEK (AUG. 1955) AND COMMERCIAL AND INDUSTRIAL ZONE, TAMAQUA, PA.

EXHIBIT 2-7

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COMPUTATION OF BENEFITS (CONT'D)

f. Increase in Commercial Area subject to flood in 50 years — 50%

g. Computation of Damages due to commercial development of Residential Area II (accelerated growth completed in 50 years, 100 year life at 3-1/4%)

($78,900(1.50) - $78,900) (.758)* = $29,900

*Average Annual Equivalent Factor, accelerated growth to year 50, constant level to year 100, at $3\frac{1}{4}$%.

h. Computation of damages due to commercial development of Area II, with project in place.
($78,900(1.60) - $78,900) (.758) = $35,900.

i. Net benefit attributable to more intensive utilization of Area II = $6,000.

j. Damages Prevented by Project

1. Commercial	
(a) Present Development	$ 78,900
(b) Increase due to development of residential Area II	29,900
2. Residential	
(a) Area I	8,900
(b) Area II*	-0-
3. Public	2,900
4. Enhancement of Area II	6,000
Total 1 + 2 + 3 + 4	$126,600

*Residential damages in Area II cease when the area is developed comercially.

19. EXPANSION

The role which water resource development may play in the growth of an economy has not been studied in depth and is therefore somewhat speculative. Unfortunately, in many public work projects, there has been a lcng lag between project construction and the realization of developmental benefits, either to the area or to the nation. The Tamaqua Flood Control Project is an attempt to show how water and related resources development can do much for early economic stimulation of the area's economy and for sustained long range growth.

To accomplish the above, complementary developments, such as highways, vocational training programs, and public health programs

are necessary. Regional economic development and national income gains are the broad goals of developmental planning. The projected demands to be met by water resources and complementary developments reflect the impact of public and private investments in stimulating regional and economic growth.

Tamaqua, with the aid of a grant from the Department of Housing and Urban Development, has prepared a comprehensive plan for the borough. Of the many plan elements, urban renewal will provide the major dollar input to the local economy. Tamaqua does not have the dollar resources to support the entire urban renewal program. Thus, it will be necessary for the borough to apply for Federal assistance. Federal assistance will be furnished only to those areas with an acceptable level of flood risk. Unless protection from flooding by Wabash Creek is provided, the renewal and rehabilitation of the key business and commercial district will be prevented. Thus, the losses associated with continued flooding by Wabash Creek would then become the sum of the flood damages and the loss to the local economy of the urban renewal inputs.

In order to demonstrate project and related capital investment effects, separate accounts are set up for national and regional benefits.

Accounts

a. National Account
   1) User Benefits
   2) Expansion Benefits

b. Regional Account
   1) User Benefits
   2) Expansion Benefits

Expansion benefits are divided into two categories, developmental and redevelopmental. Redevelopment benefits represent the incomes accruing to those persons directly employed on the water projects.

Salaries, wages, and profits on industrial and commercial investments which are related indirectly to the water project resulting from the reduction in flooding hazard and environmental improvement provided by the project are the factors to be considered in measuring developmental expansion benefits.

The national account reflects user benefits plus the wages and salaries paid to people who would otherwise be unemployed or underemployed.

The regional account reflects growth of the local economy, whether it arises from increased efficiency, e.g., employment of previously unemployed or underemployed labor, or from the transfer of economic goods and services from other regions.

Because of its geographical location Tamaqua draws its labor force from Carbon and Schuylkill Counties. In 1966 the total combined labor force in these two counties was 79,200 workers. The combined number of unemployed was 4,100 people for an unemployment rate of 5.2 percent.

The civilian labor force in Tamaqua in 1950 was 4,528 people; the number of unemployed was 240 or 5.3 percent of the labor force. In 1960, 3,769 people were in Tamaqua's civilian labor force, of this amount 544 or 14.4 percent were unemployed. The decrease in industrial, mining, transportation, trade, and service employments were the principal causes of the rise in the unemployment rate.

Without construction of the proposed project, development and rehabilitation of 5 acres of commercial area, under a grant from the Department of Housing and Urban Development, becomes an opportunity foregone. Thus, a measure of a portion of the benefits attributable to the project becomes the planned economic opportunities lost if the project is not constructed.

Local plans call for development of off-street parking, new commercial sites, re-routing of traffic, and relocation of the Borough Hall. Construction of these facilities over a five-year period would cost approximately \$1.5 million or about \$300,000 a year. At $3\frac{1}{4}$ percent the present value of this construction is \$1.36 million. Approximately 50 percent of the construction costs are wages paid to labor for a present value of wages of \$680,000. This would amount to employment for an estimated 125 people over a 5-year period at an average wage of \$6,000 per annum. It is estimated that 40 people or about 30 percent of the work force employed in this construction would otherwise be unemployed. The present value of new wages resulting from construction of the facilities to be credited to the national account is \$204,000. Amortized over a 100-year period at $3\frac{1}{4}$ percent, the national benefit for construction of commercial facilities is (\$204,000 x .03388) \$7,000.

The benefit to the regional account due to construction of the commercial facilities is the \$680,000 less \$73,000, which is the present worth of transfer payments (\$2,000 per person per year) made to unemployed labor, or 8 unemployed people each year, over a 5-year period, or \$607,000. Amortized over a 100-year period at $3\frac{1}{4}$ percent this amounts to an average annual regional benefit of approximately \$21,000.

Possible New Employment Opportunities. In order to meet Appalachian Region developmental goals and reach rough parity with the nation by year 2020, Carbon and Schuylkill Counties will need almost 80,500 new jobs. In the following table residential employment by industry for Tamaqua is shown for the year 1960 and projected to year 2020 by application of growth (or decline) percentage factors extracted from APS Developmental Benchmarks.

PROJECTIONS FOR WATER SUB-REGION "A"

Industry	Employment 1960 *	1980 **	2000 **	2020 **		Increase by 1980
Agriculture	16	10	10	10		
Mining	93	40	30	20		
Construction	170	200	300	420		
Manufacturing	1,234	1,470	1,960	2,790		
Transportation	402	290	240	250		
Trade	558	700	1,130	1,680		140
Finance	45	60	80	100	)	
Services	506	650	1,050	1,760	)	250
Public Admin.	102	180	320	550	)	
Other	99	270	300	370		
Total	3,225	3,870	5,420	7,950		

* Source: County Industry Reports of Pennsylvania Industrial Census

** Source: Application of percentage factors from OBE Developmental Benchmark Projections for Water Sub-Region "A". Figures rounded to nearest 10

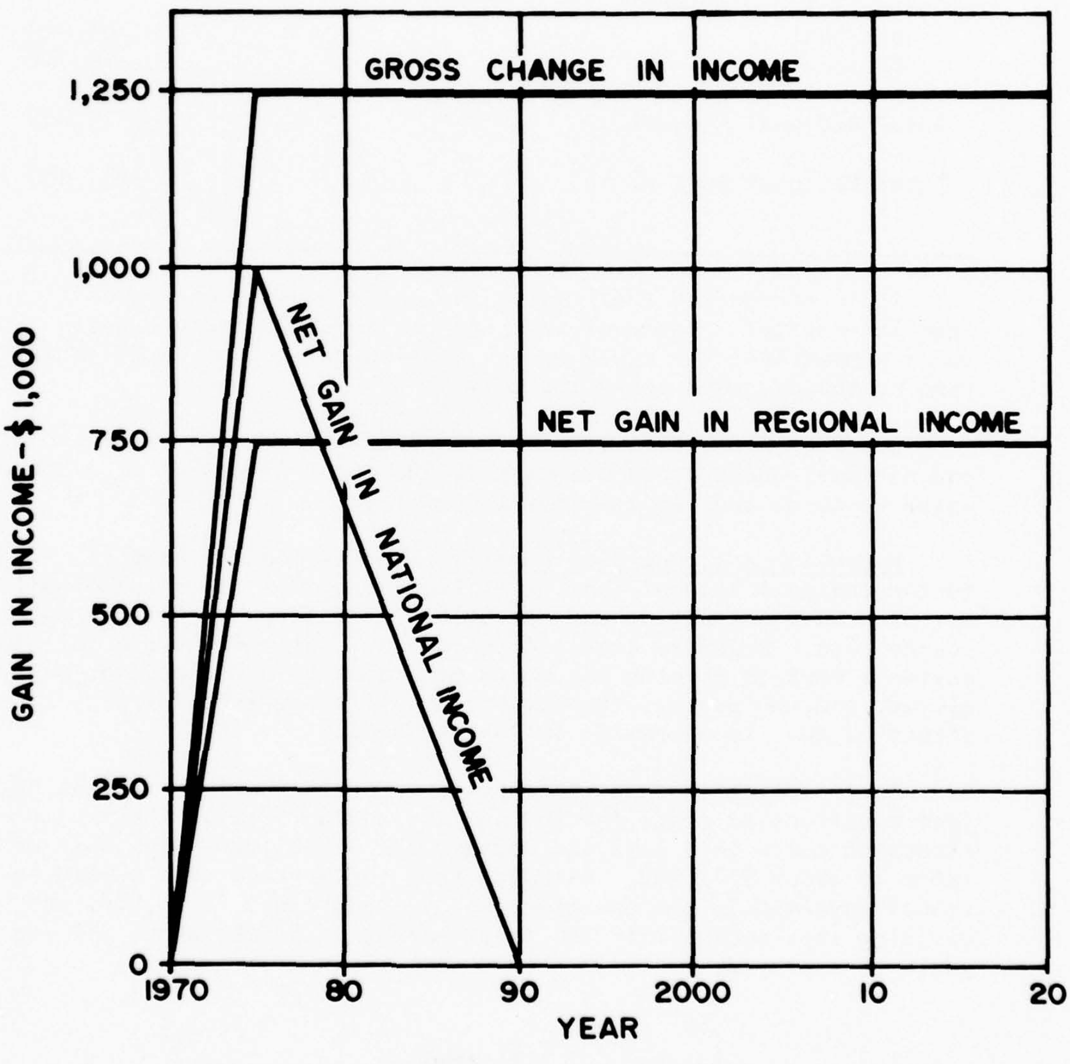
From the above table it is noted that by 1980, approximately 140 new jobs in the wholesale and retail trade sector will be required and an additional 250 in the finance, services, and public administration sectors.

Based on existing plans, a representative development of the five-acre commercial area would provide two acres for office spaces and three acres for retail purposes. It is estimated that 80 employees per acre would be utilized in offices, and 30 employees per acre may be used for retail purposes. Consequently, 80 employees per acre multiplied by two acres for office space would make available approximately 160 jobs, and 30 employees per acre multiplied by three acres for retail purposes creates approximately 90 jobs. The increased income stemming from the 250 new jobs which would eventually be created may be credited to the National Account in varying degrees, ranging from all of the new jobs in the first year, diminishing to zero after the twentieth year.

To ascertain the average national benefits the following assumptions were made: (1) the average annual wage is $5,000, (2) the number of jobs would increase by 50 per year until year 5 of the project,

and (3) the economic impact of the new employment would decrease to project year 20 when no further impact would be felt. The average annual wage ($5,000) is multiplied by an adjusted present worth factor, the result of which is then multiplied by the number of jobs per year to get the total benefits for new employment. The average annual national benefit for the 250 newly created jobs is $280,000.

Net gains in regional income from the 250 new jobs must be reduced by the level of unemployment benefit payments which would be displaced by the new jobs. Therefore, the gross annual income ($5,000) was reduced by $2,000 to the level of $3,000 for the purpose of computing regional income gains which amount to $702,000 annually. These income gains are shown in the following graph.



NET CHANGE OF INCOME WITH PROJECT

Developmental expansion benefits are summarized in table 2-5.

TABLE 2-5
SUMMARY OF DEVELOPMENTAL EXPANSION BENEFITS

Item of Benefit	Average Annual Value
Wages	
Commercial Construction	
Regional	$ 21,000
National	7,000
Commercial Employment	
Regional	702,000
National	280,000
Total Regional Account	$723,000
Total National Account	$287,000

It is recognized that to achieve these development benefits substantial capital investment from various economic sectors would have to be pumped into the study area. This investment would be in addition to the proposed project's cost.

Development benefits, therefore, are presented in the regional and national accounts to demonstrate the total effect of a combined water resource and capital investment program.

Redevelopment Expansion Benefits - Redevelopment benefits credited to the regional account consist of the average annual value of all labor used in construction and operation and maintenance of the water resource plan. Benefits credited to the national account are the wage payments made to persons who would otherwise be unemployed or underemployed, and who possess the necessary skills required for project construction and its operation and maintenance.

It is estimated that the cost of labor is about 40 percent of project construction costs (excluding land and damages). The project construction costs less land and damages are $1,943,000. The cost of labor is about $777,000. Assuming that the average wage earned by personnel involved in the construction of the project is $6,000, and dividing this amount into the total amount of wages, about 130 men would be employed.

Approximately 40 percent of the work force (52 people) employed in project construction would otherwise be unemployed. Their wages, \$6,000 per person, or \$312,000, amortized over 100 years, the project life, at $3\frac{1}{4}$ percent results in an average annual national benefit of approximately \$11,000.

The benefits to the regional account are the entire amount of wages paid to labor (\$777,000) less transfer payments (unemployment compensation at \$2,000 per person or \$104,000) and amortized for 100 years at $3\frac{1}{4}$ percent for a total average annual regional benefit of approximately \$23,000.

The operation and maintenance of the proposed project is estimated to be \$2,000 a year, of which approximately \$1,000 is the cost of labor. This amount is credited to the regional account.

Table 2-6 summarizes the redevelopment benefits.

TABLE 2-6
SUMMARY OF REDEVELOPMENTAL BENEFITS

ITEM OF BENEFIT	EXPENDITURE	LABOR COSTS	ANNUAL REDEVELOPMENT BENEFITS NATIONAL	ANNUAL REDEVELOPMENT BENEFITS REGIONAL
Construction	\$1,943,000	\$777,000	\$11,000	\$23,000
Operation and Maintenance	1)	1)	--	1,000
TOTAL			\$11,000	\$24,000

1) for life of project

SECTION VI - ECONOMIC ANALYSIS

20. INDEX OF PERFORMANCE

The index of performance relating to national income augmentation, limited to estimates of user and national redevelopment benefits to project costs is 1.7. The index of performance in regard to increasing regional incomes is portrayed by the ratio of regional income gains to total costs, 2.0 to one.

	Average Annual Benefit	Average Annual Costs	Performance Index
1.	User + Redevelopment $127,000 + $11,000	Project Costs $82,000	$\frac{138,000}{82,000} = 1.7$
2.	Regional Expansion Benefits $747,000	Total Costs $369,000	$\frac{747,000}{369,000} = 2.0$

21. ALLOCATION OF COSTS

The Tamaqua project is a local flood control project which provides expansion effects through the influence on the urban redevelopment of Tamaqua. All costs have been allocated to flood control.

SECTION VII - COST SHARING

22. COOPERATION REQUIREMENTS

Under present laws and regulations, Federal participation in a local protection project for Wabash Creek is contingent upon local interests furnishing the following items of cooperation:

a. Provide without cost to the United States all lands, easements, rights-of-way, utility relocations and alterations, and highway or highway bridge construction and alterations necessary for project construction.

b. Adjust all claims concerning water rights and hold and save the United States free from damages due to the construction works.

c. Maintain and operate the project after completion in accordance with regulations prescribed by the Secretary of the Army.

d. Prevent future encroachment which might interfere with proper functioning of the project for flood control.

23. APPORTIONMENT OF COSTS AMONG INTERESTS

Firsts costs and annual charges have been apportioned between the United States and local interests as required by law. Local interests will be required to pay for lands, easements, rights-of-way, relocations and for operation and maintenance of the project. First costs and annual charges are as shown in Section IV.

24. PUBLIC HEARING

The proposed plan of improvement was presented to the Borough Council and other interested persons at a public hearing held in

the Tamaqua Municipal Building by the District Engineer, (Philadelphia District), on 25 June 1968. Local support for the plan was unanimous. A copy of the proceedings of the public hearing is on file in the Office of the Philadelphia District. The Borough's letter, dated 25 June 1968, giving assurances of local cooperation, is reproduced on exhibit 2-8, Page III-2-45.

SECTION VIII - COORDINATION IN PLANNING

25. PLAN DEVELOPMENT PARTICIPANTS

Evolution of the plan for a water resources development program in the interest of improving the potential for economic growth in Tamaqua, Pennsylvania, involved the direct cooperation of Federal, State and county planning agencies. Federal agencies participating in plan development by providing input data and/or review capability include:

DEPARTMENT OF AGRICULTURE

Soil Conservation Service

Economic Research Service

DEPARTMENT OF ARMY

Corps of Engineers
North Atlantic Division
Philadelphia District

Office of Appalachian Studies

DEPARTMENT OF COMMERCE

Office of Business Economics

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

DEPARTMENT OF INTERIOR

Federal Water Pollution Control Administration
Bureau of Outdoor Recreation

Bureau of Sport Fisheries and Wildlife
Bureau of Mines
U. S. Geological Survey
National Park Service

Of these agencies, those concerned directly with project planning and construction are the Corps of Engineers and the Soil Conservation Service.

Non-Federal agencies contributing necessary data, review capability, and judgments as to plan compatibility with State and local development district planning included: The Commonwealth of Pennsylvania State Planning Board and the Departments of Commerce, Forests and Waters, Health, and Mines and Mineral Industries; The Northeastern (Pennsylvania) Local Development District; and Planning and Zoning Commissions in Carbon and Schuylkill Counties. In addition, valuable information used in preparation of the plan was obtained from previous studies by the Delaware River Basin Commission.

SECTION IX - CONCLUSIONS

26. CONCLUSIONS

Rehabilitation of the downtown business district of the Borough of Tamaqua cannot be accomplished by the Borough without Federal assistance because of its limited financial capability due to the high rate of unemployment and shrinking tax base. Since the blighted area is subject to frequent flooding from Wabash Creek, alleviation of this flood threat is a prerequisite for qualification for Federal assistance, as the Federal policy prohibits investment of Federal funds in developments which are susceptible to damage and disruption of operations due to periodic inundation. Therefore, the Tamaqua Local Protection Project is indispensable to the future well-being of the Borough and its feasibility has been clearly demonstrated in this report.

Borough of Tamaqua
Tamaqua, Pennsylvania 18252

HARRY W. KLECKNER
MAYOR
MARVIN B. MILAM
BOROUGH MANAGER

LEWIS H. ERBE
PRESIDENT
DONALD BECKER
VICE-PRESIDENT
B. RADCLIFFE
SECRETARY
HENRY A. BREINER
TREASURER
SPARKS A. REESE
SOLICITOR

June 25th, 1968

Col: W.W. Watkin, Jr
District Engineer
Department of the Army
Philadelphia District, Corps of Engineers
Custom House, 2nd and Chestnut Streets
Philadelphia, Penna.

Dear Colonel Watkin:

As President of Tamaqua Borough Council, I wish to welcome the U.S. Corps of Engineers, and all other interested groups and individuals here tonight to participate in the Public Hearing for the plans for improvement of the Wabash Creek.

The Town Council, at a regular meeting held June 11th, 1968, has gone on record as accepting the proposed plan and indicating that the Borough has the ability and willingness to satisfy all the requirements for local participation, such as providing without cost to the Federal Government, all lands, easements, rights-of-way, utility relocations and alterations and highway, or highway bridge construction necessary for the project, to hold and save the United States free from damages due to the construction works, and adjust all claims concerning water rights, maintain and operate the project after completion without cost to the United States, in accordance with the regulations prescribed, and to prevent future encroachments which might prevent proper functioning of the project for flood control.

Sincerely yours,
Lewis H. Erbe
Lewis H. Erbe
President, Tamaqua Borough Council

Attest:
Secretary

Exhibit 2-8

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REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSIS

CHAPTER 3

ROYAL GLEN RESERVOIR PROJECT
POTOMAC RIVER BASIN
WEST VIRGINIA

Office of Appalachian Studies

Corps of Engineers

September 1969

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PART III

PROJECT ANALYSES

CHAPTER 3 - ROYAL GLEN PROJECT

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CHAPTER 3 - ROYAL GLEN PROJECT

LIST OF EXHIBITS

PART III

PROJECT ANALYSES

CHAPTER 3 - ROYAL GLEN PROJECT

SECTION I - SUMMARY

1. PHYSICAL DESCRIPTION

Royal Glen multiple-purpose project site is located in the Valley and Ridge physiographic province in Grant County, West Virginia, about 115 air miles west of Washington, D.C. (see exhibit 3-1). The project would consist of two elements: a multi-purpose reservoir on the South Branch Potomac River just below the mouth of the North Fork South Branch Potomac River, 3.6 miles west of Petersburg, West Virginia; and improvement of the river channel through Petersburg to increase the degree of flood protection to 500 acres of potentially developable land strategically located in regard to existing urban areas and existing and proposed transportation routes.

Major physical features of the reservoir element of the project would be the 643-foot long concrete dam with a gated spillway in the channel section, a 940-foot earthen dike in a low saddle about 0.7 mile north of the dam, and the outdoor recreation facilities of the 1,150-acre reservoir and adjacent areas. Flows through the structure would be controlled by the three 42' x 47' tainter gates of the spillway, two operational 7' x 12' sluices with inverts near the streambed, and a low-flow-sluice in the left abutment. The reservoir impounded by the structure would have a conservation pool to elevation 1060 (capacity 1.1 inches of runoff from the contributing drainage area) and a flood control pool to elevation 1117 (total capacity 128,000 acre feet or 3.8 inches of runoff). Detailed studies during preconstruction planning would determine the exact elevation of the pool to be consistent with existing natural and scenic values. The 148-foot high dam would control a drainage area of 640 square miles. The reservoir would be entirely within the limits of the Spruce Knob-Seneca Rocks National Recreation Area and will be developed in cooperation with the Forest Service to provide recreation areas with appropriate public use facilities. The channel improvement would be an integral part of the project; would modify about 2.4 miles of the river channel at Petersburg; and would augment the flood reduction capability of the reservoir to protect high-potential industrial development tracts along the river from floods up to the magnitude of the 100-year flood.

2. PROJECT IMPACTS

The Royal Glen multiple-purpose project has been formulated to provide water control services which will both meet needs and relieve water related developmental impediments for an area extending downstream past Petersburg, West Virginia. The specific benefits realized from the project would be:

a. Flood damage reduction and change of land use availability.

b. Increase of water-based outdoor recreation activity.

c. Improved fishing in the reservoir pool and along tailwater areas.

d. Augmentation of regional income from the expenditures of users of recreation facilities and from industrial development on relatively flood-free land provided by the project.

The project is specifically designed to minimize conflicts with the high scenic and natural values common to the area while achieving these benefits.

3. COST AND BENEFITS

Costs for constructing the Royal Glen multiple-purpose project are estimated at $29,080,000 and annual economic charges are estimated to be $1,192,000. The economic development which can be attributed to the project will cost about $178,298,000, with annual charges estimated at $4,036,000. Annual benefits for the development are estimated as follows ($1,000):

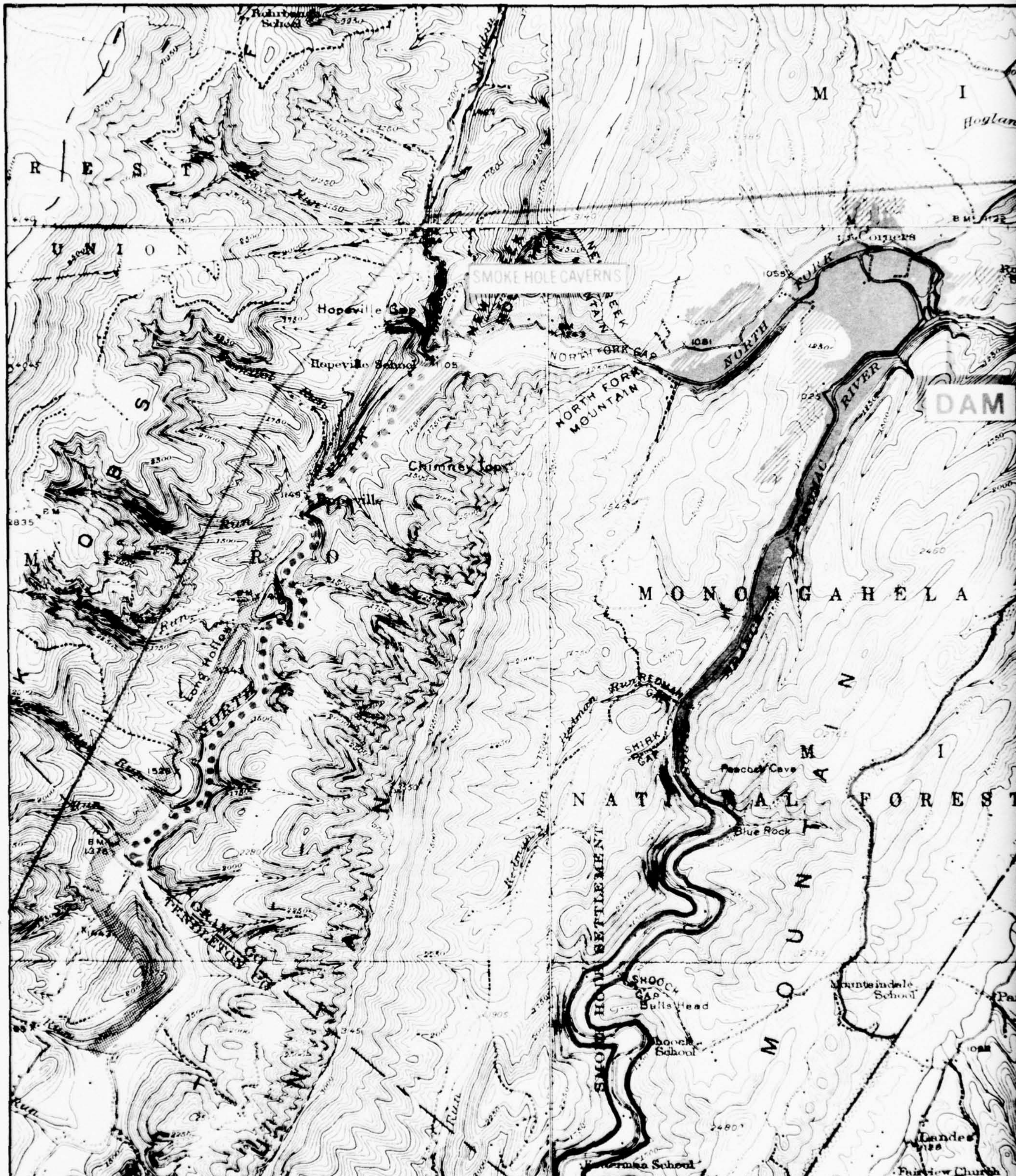
	National	Regional
Users of Water Services	$1,459.	$1,293.
Expansion Effects		
Redevelopment	124.	214.
Developmental	4,151.	7,227.
Offset for loss of income-reservoir lands	(36)	(128)
Total Expansion	$4,239.	$7,313.

A comparison of costs and benefits indicates that a minimum index of performance in relation to increasing national income, derived by the ratio of user plus national redevelopment benefits to project economic costs, is 1.3 to one. The ratio of total regional benefits to total economic costs indicates a relative index of performance in regards to increasing regional income of 1.4 to one.

4. COOPERATION REQUIRED FOR CONSTRUCTION

In accordance with present Federal policy, the costs of the project have been assigned to the Federal Government.

The channel improvement is considered to be an integral part of project which: (a) achieves the goal of providing a high degree of flood protection, to those areas where development is expected to occur,



SMOKE HOLE CAVERNS
DAM
Hopeville Gap
Hopeville School
Chimney Top
NORTH FORK GAP
NORTH FORK MOUNTAIN
NORTH FORK
RIVER
MONONGAHELA
NATIONAL FOREST
Peacock Cave
Blue Rock
SHIRK GAP
Redman Run
Long Hollow
GRANT CO
PENDLETON CO
UNION
Bulls Head
Mountaindale School
Fairview Church

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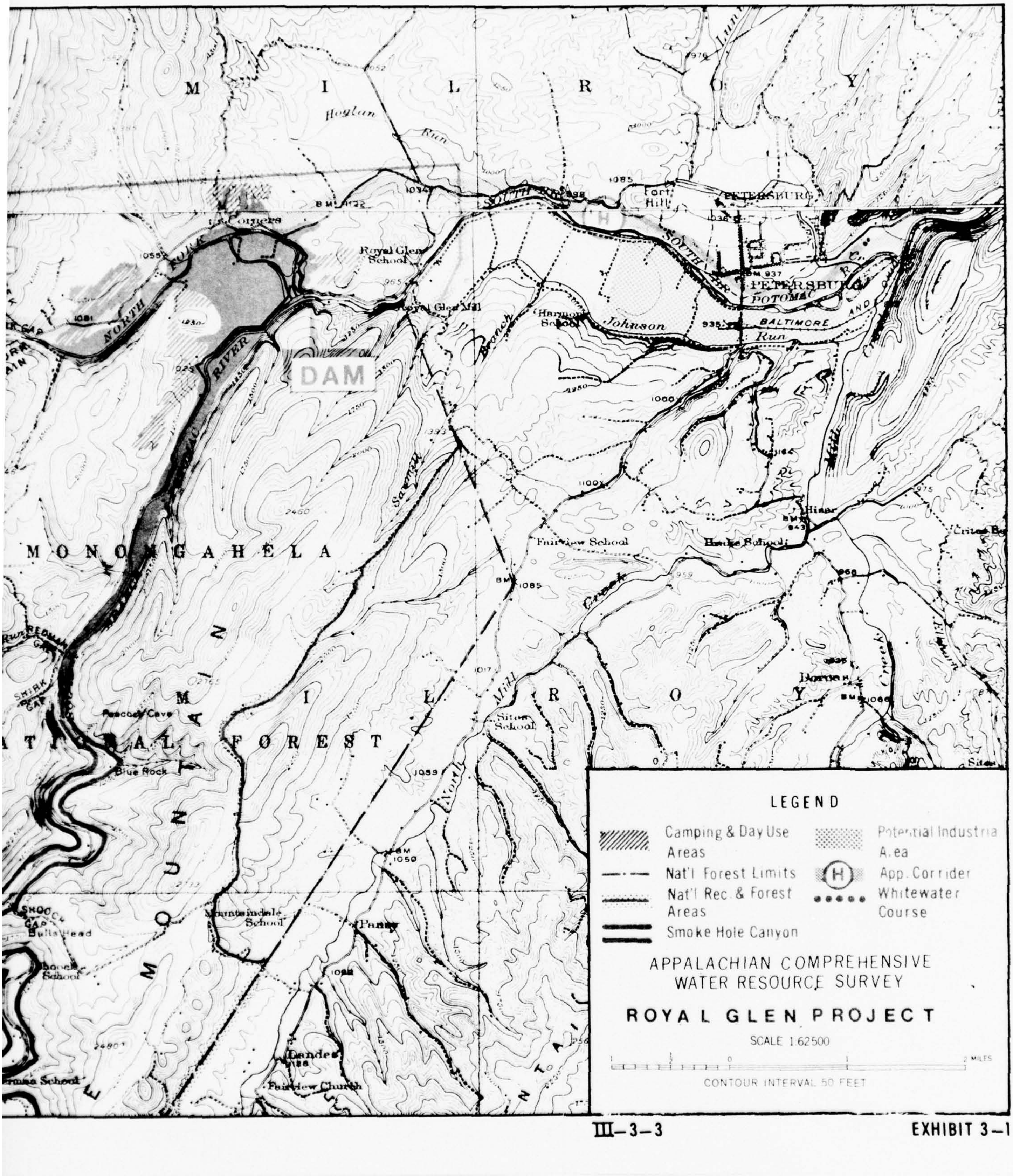

EXHIBIT 3-1

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and (b) allows reservoir regulation procedures which preclude potential adverse effects on the Smoke Hole Caverns, the Smoke Hole Canyon, the upstream whitewater canoe course, and the other existing natural and scenic values in the area. Since the flood control benefits extend many miles downstream and the economic expansion related to flood control features would impact directly on a four-county area within commuting distance of Petersburg, the benefits are considered widespread and apportionment of the flood control costs to the Federal Government would be appropriate.

The Royal Glen Project is located in the Spruce Knob-Seneca Rocks National Recreation Area and within boundaries of the Monongahela National Forest. According to Section 1(c), of the Federal Water Projects Recreation Act (PL 89-72) the project is appropriate for administration by a Federal Agency. The Forest Service of the U.S. Department of Agriculture has stated that the agency would cooperate and participate in planning and developing of recreational facilities and would assume absolute responsibility for maintenance and operation of the recreational features of the Royal Glen Project.

Prior to construction, non-Federal interests should furnish assurances that they will establish downstream encroachment lines to permit efficient reservoir regulations, to the full extent of their legal capability to enact flood plain management regulations which will guide development of the flood plain to achieve economic development objectives and to preclude catastrophic flood losses.

Close coordination among the State of West Virginia, the Forest Service (USDA), and the Corps of Engineers should be maintained during the planning stages of the proposed reservoir and Corridor H to avoid possible conflicts.

SECTION II - PROJECT FORMULATION

5. HISTORY OF THE ROYAL GLEN PROJECT

A proposal for developing a reservoir at the Royal Glen site to include flood control, water quality control and recreation purposes was included in the Potomac River Basin Report (1963). The project met intense local and state objections because of the conflict with scenic and natural values, leading to submission to the West Virginia Legislature of a resolution to prohibit development of the project. The Chief of Engineers' report does not recommend the project, as then formulated, for authorization, to meet the immediate needs of the Potomac Basin. The report does, however, state that the project is being restudied in the Appalachian Water Resources Survey.

Additional studies indicated that a lesser amount of flow augmentation into the head of the Potomac estuary, in conjunction with other local programs, appeared a better solution to the water quality problems in the estuary.

During screening studies, leading to selection of projects to be included in the Appalachian Water Resources Survey, the representatives of the State of West Virginia proposed a review of the project, scaled to meet pressing needs for flood damage reduction, to provide much-needed slack-water recreation opportunities, to complement the overall scenic and aesthetic assets of the area, while avoiding the destruction of existing natural and scenic values. This strategy was considered to meet both developmental and environmental objectives of the State and region. This document presents the results of the investigation and recommendations for authorization of the project as formulated herein.

6. NEEDS THAT POTENTIALLY CAN BE MET BY DEVELOPMENT OF WATER RESOURCES

Current (1967) damages for overbank flooding in the benefit area of the Royal Glen Project amount to $523,000 annually. With normal development, reflecting increases in population and real incomes, the damages are estimated to increase to $1,050,000 annually in 100 years.

Natural streamflow appears to be adequate in both quantity and quality to meet foreseen water supply needs and to maintain water quality standards in the South Branch.

The Bureau of Outdoor Recreation*/ has estimated a gross demand for over ten million annual activity days for boating, swimming, picnicking, and camping in the nine-county recreational market area surrounding the

*/ See Appendix F, Recreation and Aesthetics, Bureau of Outdoor Recreation.

Royal Glen site by 1980. Gross demand is expected to increase to 18 million annual activity days in 2000 and over 26 million by 2020. Present needs are 765,000 annual activity days for boating, 1,430,000 for swimming and 940,000 for picnicking. At present, there are about 150 acres of impounded water available for outdoor recreation use in the 40-mile radius of the project site suitable for boating and other water-dependent activities.

Location of the project within a National Recreation Area and in a National Forest augment the scenic and aesthetic attributes of the area. Provision of additional slack water within the area would add to the potential for developing a recreational industry.

Petersburg has been identified as a growth center in the State of West Virginia Development Plan. The area is ranked as a supplemental investment area, which indicates a strategy to make investments which would make the area more attractive to new investment and provide urban services to serve surrounding rural areas as well as the center. Appalachian Corridor H will enhance the locational advantages of the area. While the shortage of land with favorable terrain is not as severe as for many portions of West Virginia, the present occurrence of heavy flooding damage indicates the pressure for flood plain development. The long range development plans for Grant County and Petersburg, West Virginia, identify the existing flood plain at Petersburg as having high potential for industrial development, as shown on exhibit 3-19. The flood plain at Petersburg is serviced by rail and highway systems and has substantial advantages for industrial development. Effective water control measures in connection with flood plain management programs can be utilized to guide development of the area in a manner which will stimulate economic development of the area.

7. ALTERNATIVES AVAILABLE FOR MEETING THE NEEDS

The Royal Glen Dam site is a unique feature of the topography of this portion of the sub-region. There are only a few potential damsites in the South Branch Valley, and no other that provides a comparable storage potential without destroying existing development or high natural values. Comparable slack-water storage, particularly within the National Recreation Area, could not be adequately developed elsewhere. A series of dispersed headwater reservoirs on small drainage areas might be developed to meet part of the slack-water recreation needs, but could not provide other services comparably. The management plan for the Spruce Knob-Seneca Rocks National Recreation Area states that small headwater reservoirs will also be needed in addition to the Royal Glen Project. A series of levee projects could afford a comparable degree of local protection from flooding at Petersburg and along intervening areas where possibly warranted, but the effect would be confined to the existing damage potential due to topographic conditions and economic limitations.

Structural measures reviewed were those contained in the Potomac River Basin Report of February 1963, and included local protection at Petersburg and Moorefield and a number of upstream storage sites for flood control. The same sites, as well as a few scattered headwater reservoir projects, one existing, could also be developed for limited recreation use. These project alternatives also served as a background for project formulation.

The alternatives studied would not, however, provide the same services as the Royal Glen Project, especially with respect to recreation activities. The benefit from a significant water-oriented recreation area could not be duplicated by a series of small headwater reservoirs. Even with the recreation complex at the Royal Glen Project, small reservoirs located throughout the National Recreation Area would still be necessary for balanced overall development of the area to meet future needs for recreation. Additional lakes must be developed to accommodate the anticipated increase in fishing and water-oriented recreation needs.

Non-structural alternatives, while beneficial to recreation, would not meet the slack-water demand. The flood damages can be reduced by evacuation, permanent or temporary, of the flood plain. But this alone would not assist in meeting the Appalachian Regional objectives, even if the flood damage problem could be effectively and economically reduced.

Studies by the U.S. Department of Agriculture show that reservoirs and land treatment measures in upstream areas can be effective and economically feasible in providing local water resources services and controlling runoff and sedimentation. Such studies have and are being made for three upstream watersheds directly involved or affecting the Royal Glen Study area. They are the authorized Lunice Creek Upstream Watershed Project and the South Branch and North and South Mill Creeks watershed areas currently being planned. This project and potential projects cannot provide the degree of flood protection in the Petersburg area needed for the planned development. However, they, along with the recommended accelerated land treatment program for the drainage area above the proposed Royal Glen reservoir, will provide useful supplements to the benefits arising from the Royal Glen project. Full coordination will be maintained during final detailed planning of the Royal Glen project and the two upstream watersheds. Further details on USDA's recommended programs can be found in Appendix A - Agriculture, Forestry and Conservation.

The Royal Glen Reservoir is the most logical structural alternative, and the most effective and economical means of meeting flood control and part of the recreational needs in the upper South Branch Valley. The project will stimulate economic development in Petersburg in a manner that is primarily responsive to avoiding disruption to the high natural values in the area. Alone, the reservoir would provide protection against the 50-year flood to potential prime industrial sites.

A higher degree of protection to these high-potential industrial sites is essential for realization of the economic development goals for this area. Several alternatives are available to achieve the desired level of protection. These alternatives are: (1) increase the flood control storage in Royal Glen Reservoir; (2) provide channel improvement downstream from the reservoir through the town of Petersburg, West Virginia; (3) flood plain management; and (4) construction of levees to protect the high-potential industrial sites.

In considering these alternatives, a minimum standard of protection against the 100-year flood was established in areas where development is to be encouraged (See exhibit 3-1) and to maximize net flood control benefits after development or minimize flood losses after development. This land is located on the flood plain and is convenient to existing rail and highway systems. To provide the 100-year frequency protection, the necessary additional element in the plan for development of the South Branch Valley was determined by a comparison of the alternatives mentioned above.

Flood plain management, when considered as a single alternative, is not acceptable since strict adherence to a zoning plan which would restrict development in the flood plain would not be responsive to the Appalachian objective. However, flood plain management and flood proofing of buildings erected in the protected flood plain would be a very valuable element in the development plan in addition to structural measures which provide protection against the 100-year flood. Such measures would minimize losses from more severe events.

The provision of additional flood control storage in Royal Glen Reservoir was considered. The additional storage required would be about 71,000 acre feet and would raise the elevation of the dam an additional 27 feet. The increased cost of the reservoir would be $4,400,000 with an estimated increase in average annual costs of $176,000. More importantly, the higher dam would have serious adverse effects on the high natural and scenic values shown on exhibit 3-1. Based on strong opposition to the project as formulated in the 1963 Potomac River Basin Report and recent discussions with State representatives, it is highly doubtful that the State of West Virginia would accept or support a higher reservoir project.

A levee system to provide adequate protection to the prime industrial land was also evaluated. A system of levees was investigated to provide the developable area with protection against the Standard Project Flood (to the top of levees) as modified by the Royal Glen Reservoir. The cost of the system is estimated at $3,140,000 with an average annual cost of $157,000. This system would protect Petersburg and would require elaborate internal drainage facilities.

Another alternative studied was a channel improvement to clear and widen the existing channel to provide sufficient unimpeded cross section to accommodate the 100-year flood peak as modified by the

hydrologic data were used to determine the flood profiles for the natural and modified conditions through the town of Petersburg. The profiles resulting from these studies are shown on exhibit 3-2.

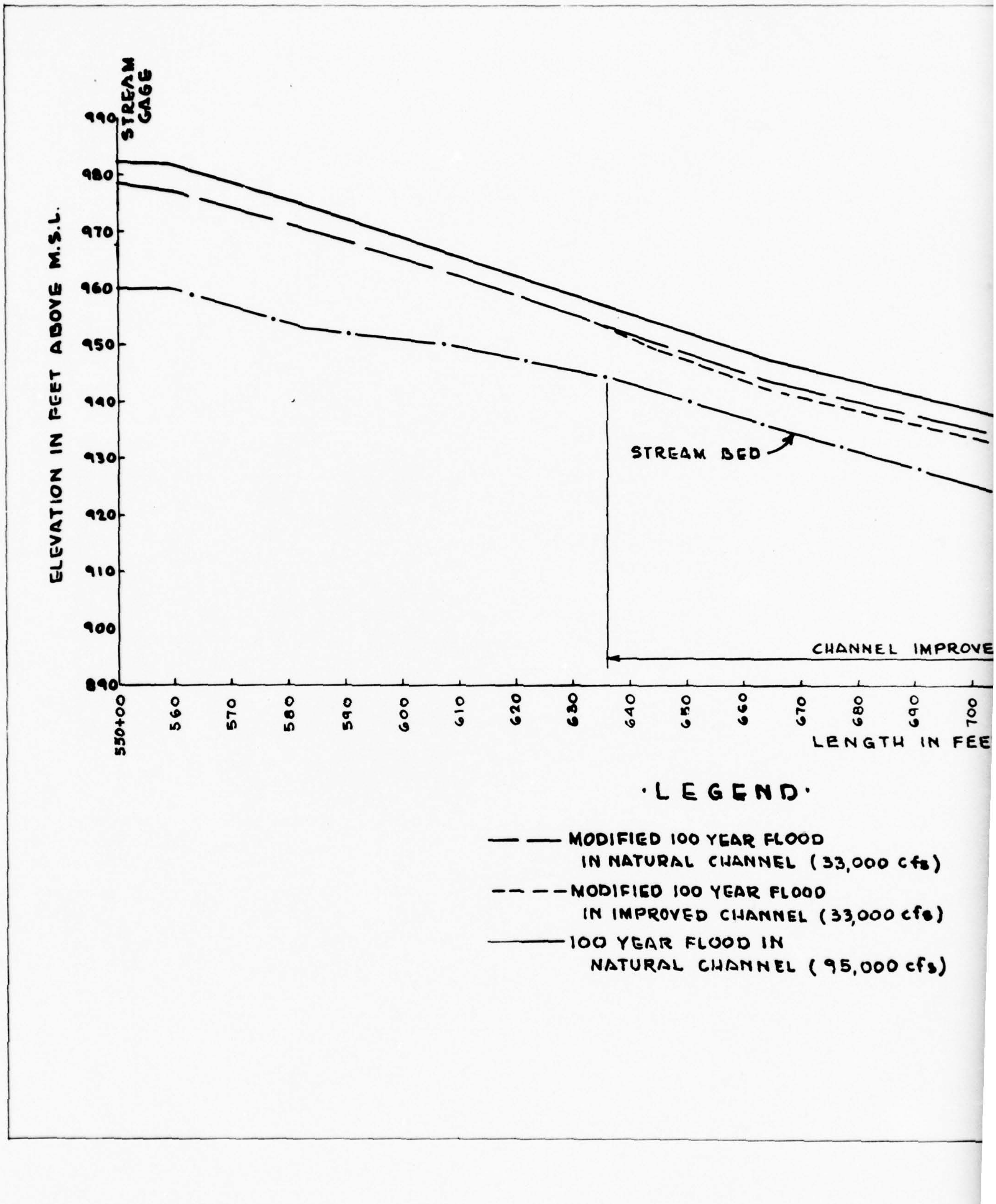
Studies were made for varying degrees of channel modifications to determine the effect on reduction of flood stages. One of the profiles on exhibit 3-2 shows the results of channel clearing and modification within the overall limits of the existing channel. By elimination of restrictions and excavation at critical cross sections, the modified 100-year flood would be essentially contained with the channel at a first cost of $1,210,000 and an average annual cost of $60,500.

The alternatives for providing protection to the prime industrial land against damages from the 100-year flood were compared on the basis of economics and on desirability, or the ability of the alternative to give the desired results. Additional storage in the reservoir was eliminated because of its adverse effect upstream from the damsite and its high cost. Flood plain management in the form of restrictive zoning was eliminated because it could stifle development at Petersburg rather than stimulate the local economy. Flood plain management in the form of zoning, flood proofing, and warning and evacuation should be a part of an overall development plan and therefore should be considered by local or state officials as an integral part of any combination of structural alternatives. A levee system could be very effective but, due to design requirements, would be very expensive and would require some of the developable land as right-of-way. The most economical alternative that would have minimum environmental disruption and still provide protection against the 100-year frequency flood, as modified by the reservoir, is a channel improvement project. Therefore, to provide the degree of protection desired for the prime industrial land, and meet the Appalachian objective of a development plan, channel improvement was selected for the plan. A comparison of alternatives is shown below:

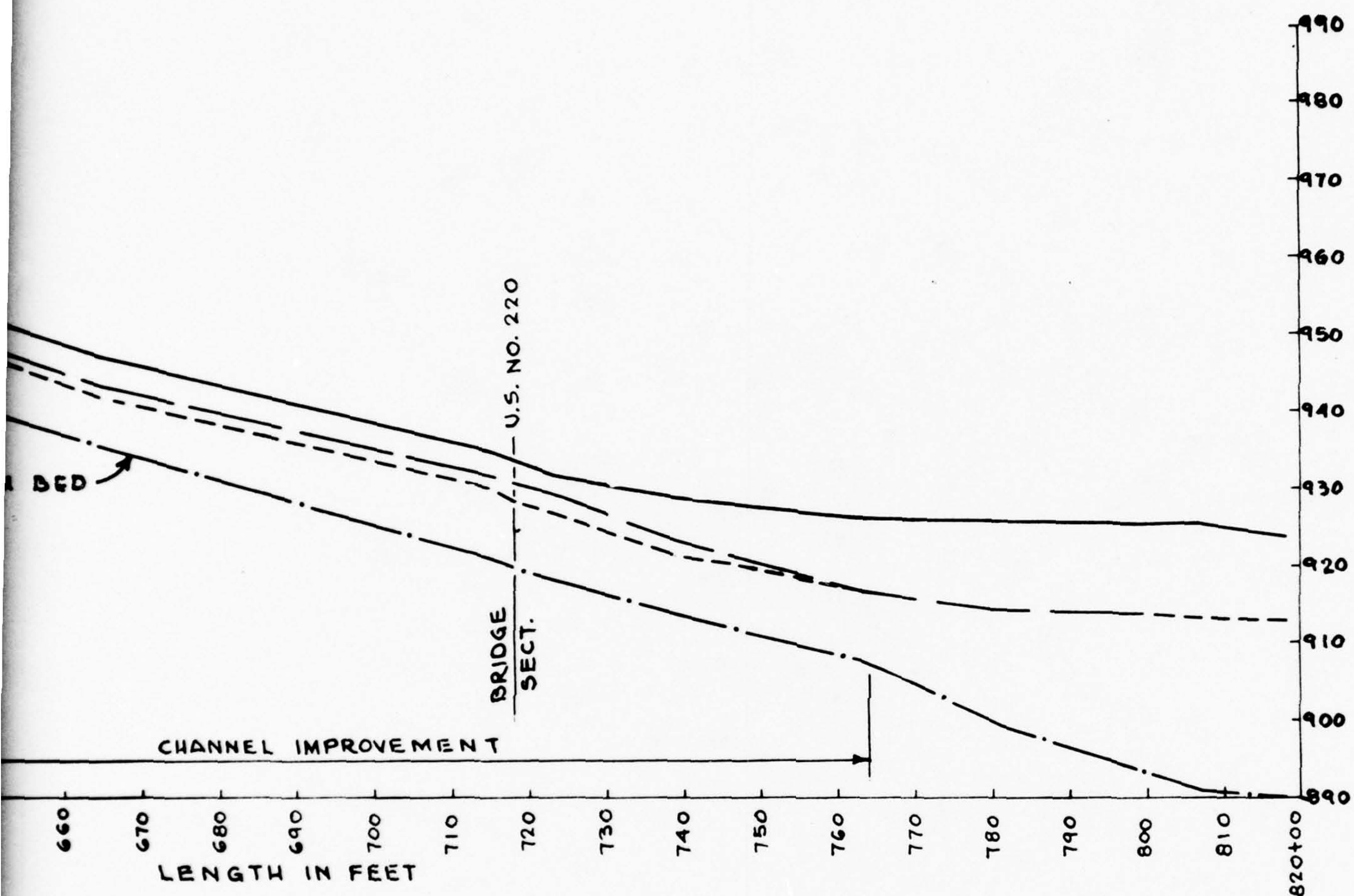
Alternative	First Cost	Average Annual Cost
Additional Storage	$4,400,000	$176,000
Channel Improvement	1,210,000	60,500
Levee System	3,140,000	157,000

8. SELECTED PROJECT

The total project plan includes a reservoir at the Royal Glen site for recreation and flood control, and improvement of the channel through the Petersburg area. The channel would accommodate a flow of 33,000 cfs, which is the regulated peak discharge from the reservoir for a 100-year reservoir design flood. The top of the dam would be at elevation 1130 feet msl and usable reservoir storage would be 128,000 acre feet. The project plan should also be complemented by a flood plain management program under local or state government responsibility.


STREAM GAGE
ELEVATION IN FEET ABOVE M.S.L.
990
980
970
960
950
940
930
920
910
900
890
STREAM BED
CHANNEL IMPROVE
550+00
560
570
580
590
600
610
620
630
640
650
660
670
680
690
700
LENGTH IN FEE
·LEGEND·
MODIFIED 100 YEAR FLOOD IN NATURAL CHANNEL (33,000 cfs)
MODIFIED 100 YEAR FLOOD IN IMPROVED CHANNEL (33,000 cfs)
100 YEAR FLOOD IN NATURAL CHANNEL (95,000 cfs)

2



GEND·

YEAR FLOOD
CHANNEL (33,000 cfs)

YEAR FLOOD
D CHANNEL (33,000 cfs)

LOOD IN
CHANNEL (95,000 cfs)

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

ROYAL GLEN PROJECT

SOUTH BRACH POTOMAC RIVER W.VA.
WATER SURFACE PROFILE@PETERSBURG

Drawn by:__________ Approved:__________
Title:__________
Checked by:__________ Date:__________

EXHIBIT 3-2

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The conservation pool of the Royal Glen Reservoir is limited within the reservoir area, from a recreation viewpoint, by existing natural values, and the shape of the reservoir area and shoreline. Little additional surface area is attained by increasing the conservation pool beyond an elevation of about 1060 feet above mean sea level (msl). At significantly higher elevations, steep shoreline slopes would fringe most of the pool when at its normal full level. Further a reach of the South Branch with valuable trout fishing and scenic value would begin to be flooded by a permanent pool above an elevation of 1060 feet (msl). Exhibits 3-3, 3-4, and 3-5 show pertinent details of the Royal Glen Project.

The conservation pool at elevation 1060 feet msl would store about 38,000 acre feet which would be used for recreation and enhancement of fishing values downstream in the South Branch and allow for sediment deposition. Flood damage reduction would be achieved by the ability to retain and control about 90,000 acre feet of flood runoff. The Royal Glen Project would be fully compatible with the Appalachian Regional objectives and the high quality recreational character of the valley.

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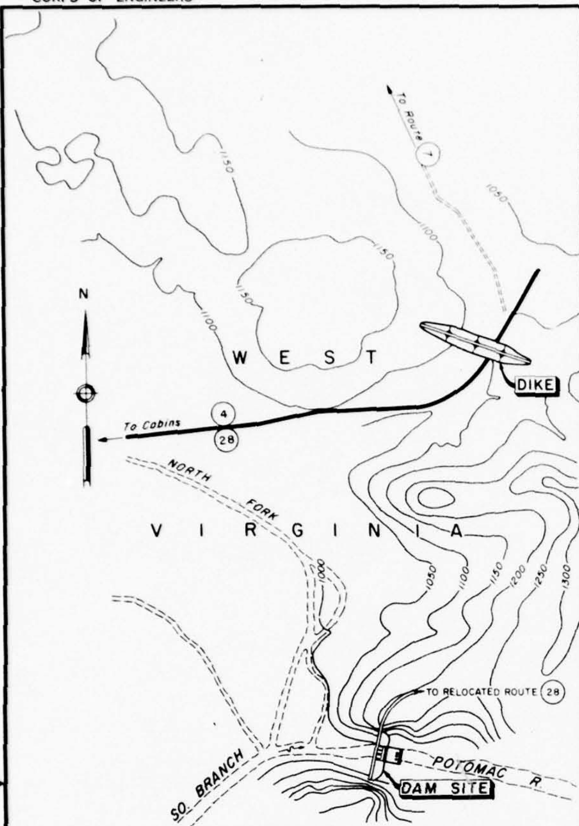
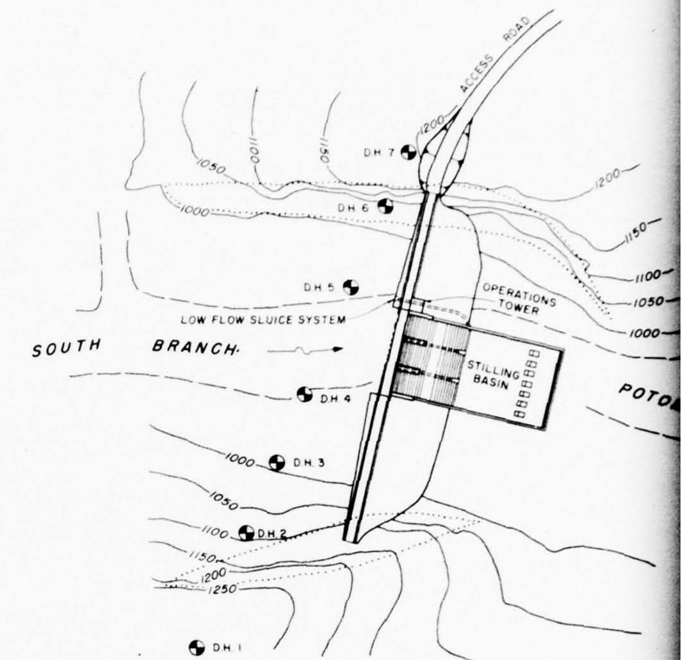
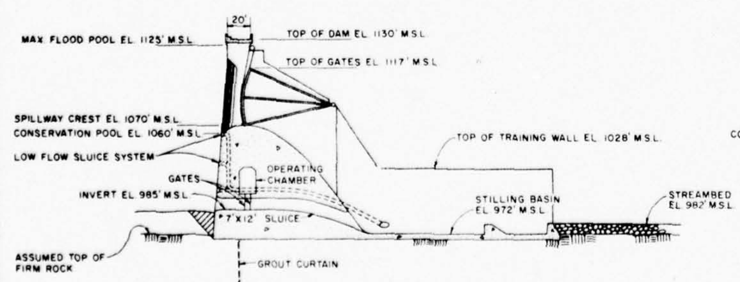


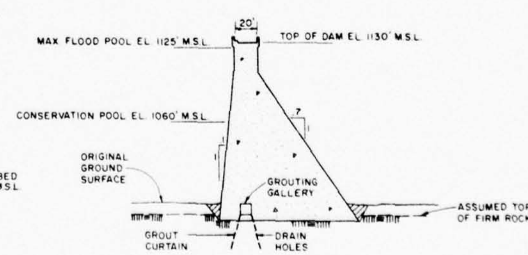
SITE MAP



PLAN

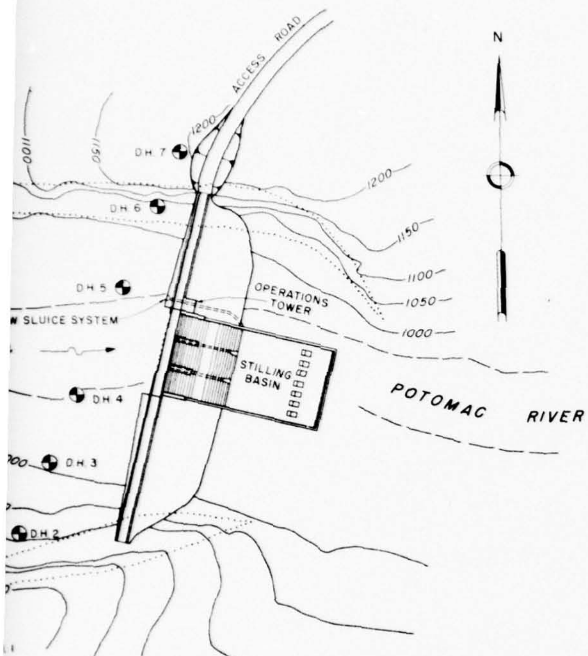


TYPICAL OVERFLOW SECTION



TYPICAL NON-OVERFLOW SECTION

U. S. ARMY

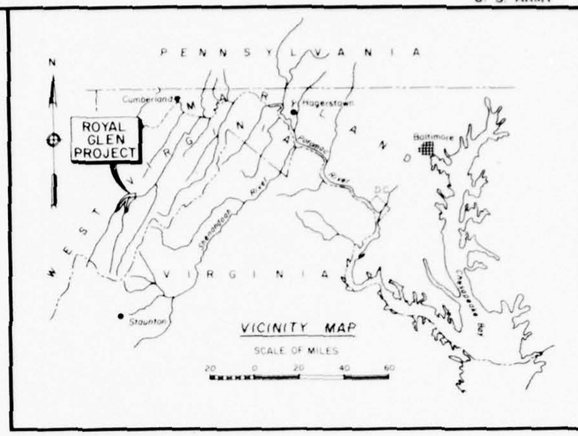


PLAN

SCALE OF FEET 0 100 200 300 400

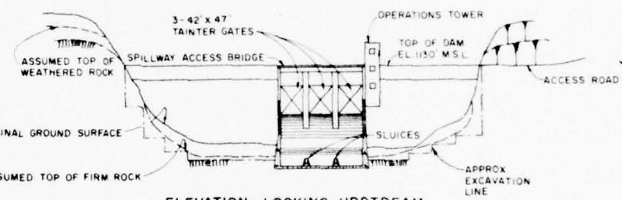
LEGEND

ROCK OUTCROP
DRILL HOLE



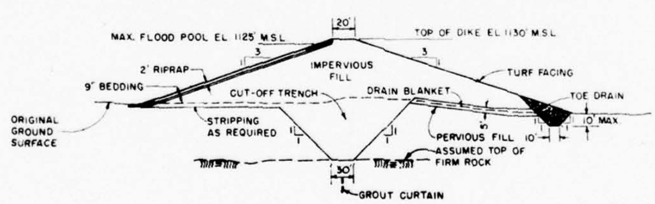
VICINITY MAP

SCALE OF MILES 20 0 20 40 60



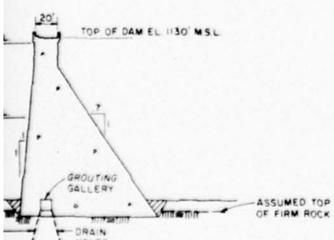
ELEVATION - LOOKING UPSTREAM

SCALE OF FEET 100 0 100 200 300



TYPICAL EARTH FILL DIKE SECTION

NOT TO SCALE



L NON-OVERFLOW SECTION

SCALE OF FEET 0 50 100 150

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

ROYAL GLEN PROJECT

SOUTH BRANCH POTOMAC RIVER W. VA.

PLAN AND SECTIONS OF DAM AND DIKE

SCALE: AS SHOWN

Drawn by: M.C., M.M.H. Approved: ____
Checked by: L.J.J. Title: ____
Date: ____

EXHIBIT 3-3

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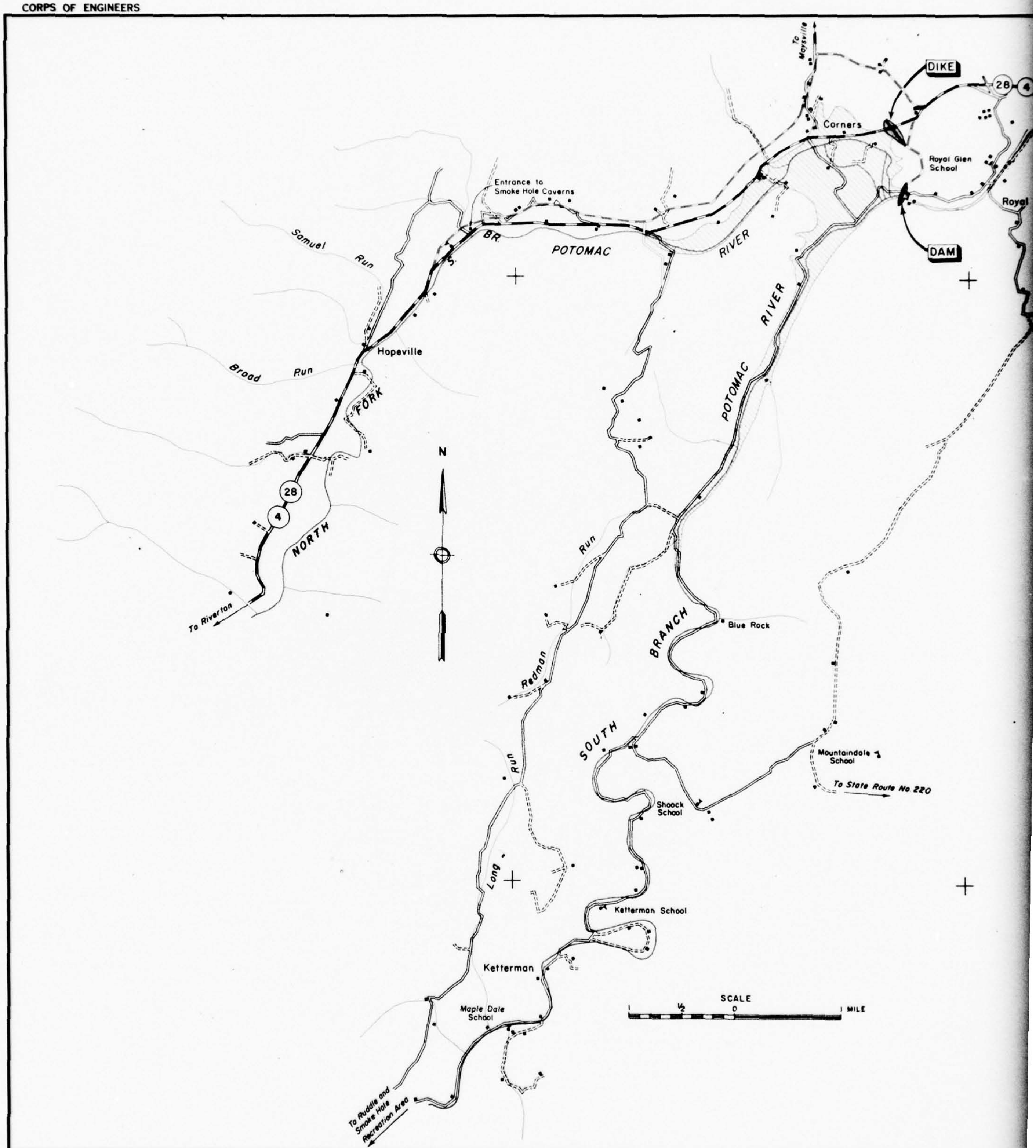

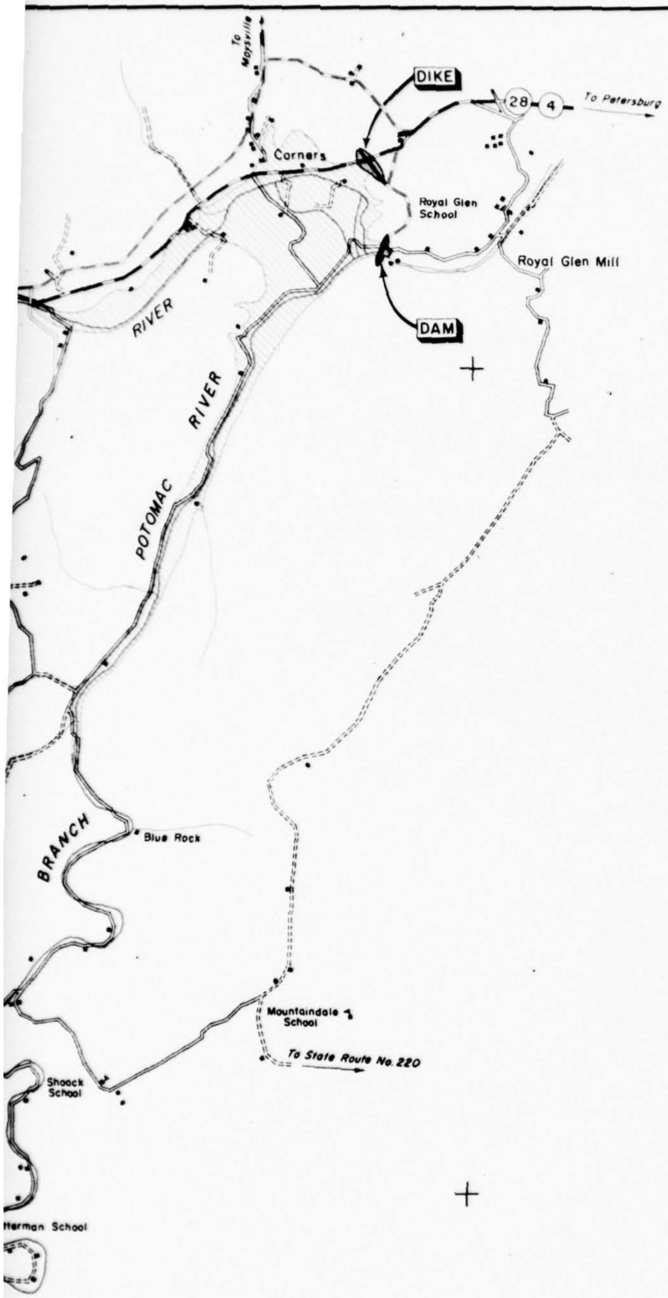

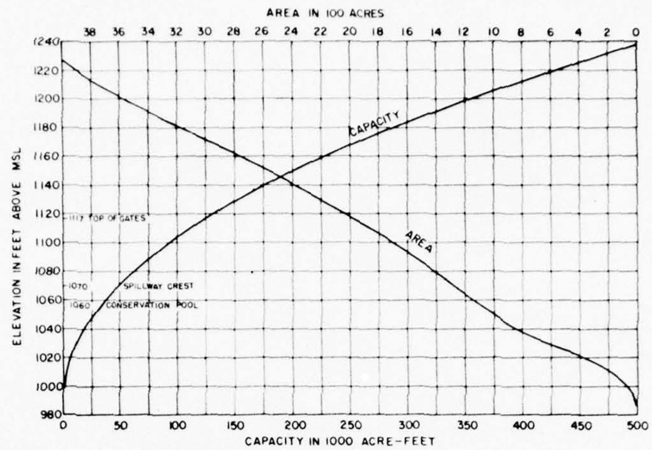

AREA-CAPACITY RELATIONSHIPS

LEGEND

	EXISTING	RELOCATED OR IMPROVED
PAVED ROAD, FIRST CLASS		
PAVED ROAD, SECOND CLASS		
GRAVEL ROAD		
DIRT ROAD		
BUILDING		
CHURCH		
SCHOOL		
STATE HIGHWAY		
RIVERS & STREAMS		
CONSERVATION POOL-EL 1060 M.S.L.		

NOTE: LOCATION OF APPALACHIAN CORRIDOR H WILL BE COORDINATED WITH STATE OF W.VA. AND FOREST SERVICE.

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

ROYAL GLEN PROJECT

SOUTH BRANCH POTOMAC RIVER, W. VA.

RESERVOIR AND RELOCATIONS

SCALE

Drawn by: M.C., M.M.H.
Checked by: L.I.J.
Approved: ____
Title: ____
Date: ____

EXHIBIT 3-4

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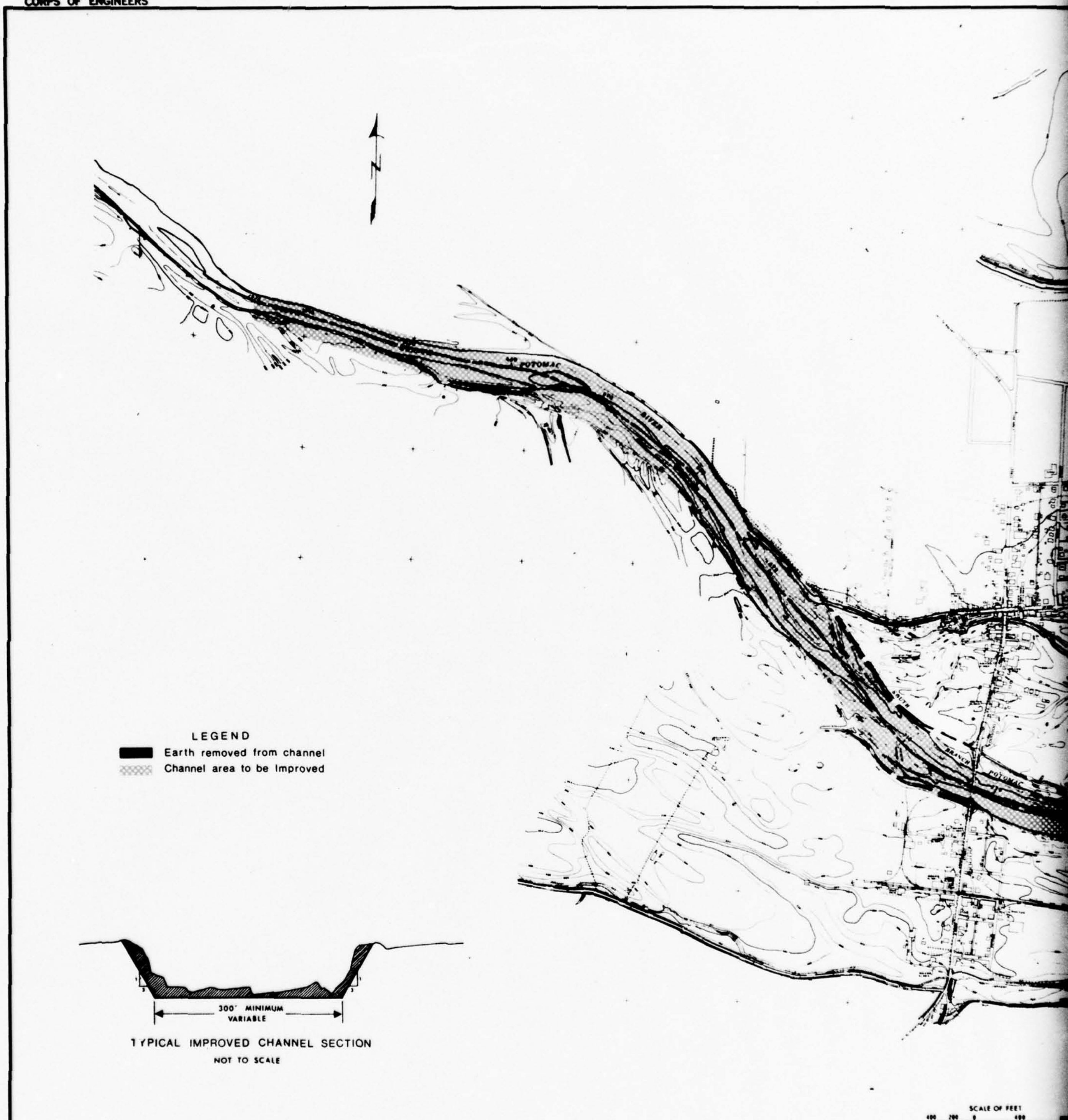
CORPS OF ENGINEERS



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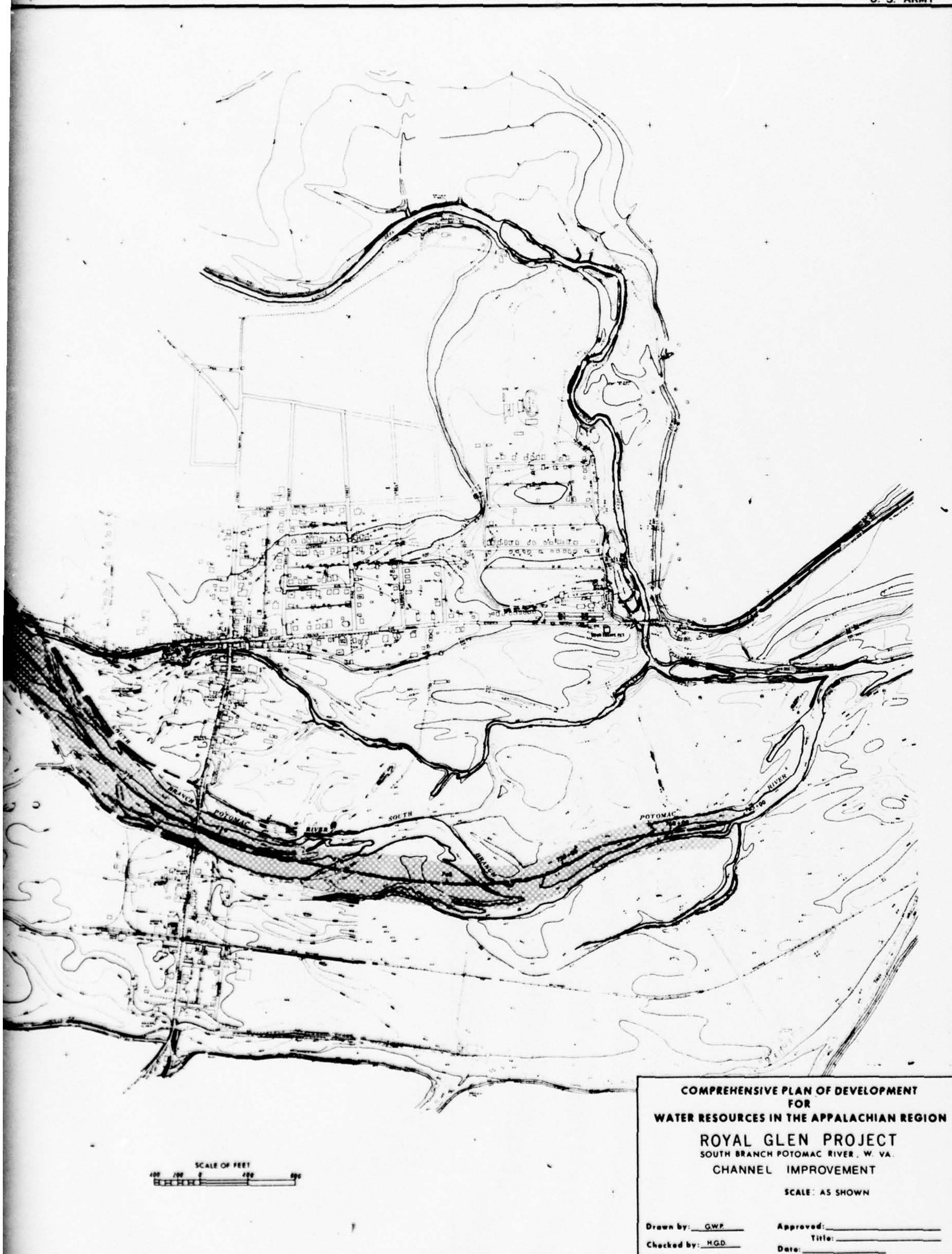
U. S. ARMY



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

ROYAL GLEN PROJECT
SOUTH BRANCH POTOMAC RIVER, W. VA.

CHANNEL IMPROVEMENT

SCALE: AS SHOWN

Drawn by: G.W.P.
Checked by: H.G.D.
Approved:
Title:
Date:

EXHIBIT 3-5

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SECTION III - DESIGN CONSIDERATIONS

9. INTRODUCTION

Design of Royal Glen Reservoir project involved several hydrologic analyses to establish structural dimensions to assure that the project would accomplish the desired objectives while satisfying criteria to protect the integrity of the structure and to avoid violation of restrictions to preserve unique and irreplaceable natural resources. Preservation of Smoke Hole Caverns and the white-water canoeing reach of the North Fork South Branch establishes the elevation limit on reservoir storage and possibly adverse effect of prolonged inundation on decorative vegetation adjacent to the reservoir requires evacuation of the flood control storage at the maximum rate consistent with downstream conditions. The upper limit of the conservation pool was established to take advantage of desirable locations for recreation facilities development, thus establishing the lower limit of the flood pool.

Geologic investigations to determine the structural strength of underlying formations and probabilities of significant reservoir leakage were necessary to determine suitability of the site. After determination of the storage allocations and hydraulic design of the structure, studies were made to determine real estate acquisition and relocation requirements. Recreation facilities were planned to serve the predictable usage of the project area by general recreationists and reservoir and stream fishermen.

10. HYDROLOGIC

Description and Features of Watershed

The South Branch Potomac River is shown on exhibit 3-6. From its source near Monterey, Virginia, it flows 131 miles generally northeast and joins with the North Branch to form the Potomac River approximately 285 miles above the mouth at Chesapeake Bay. The river flows through rugged terrain between the Appalachian Mountains on the east, and the Allegheny Mountains on the west. The slope of the river is about 43 feet per mile above Petersburg, West Virginia, but reduces sharply to about 5 feet per mile from Petersburg to the mouth. The watershed above the damsite drains an area of 640 square miles. The total drainage area of the South Branch is 1,493 square miles. The South Fork tributary of the South Branch, also knows as the Moorefield River, has a 64-mile long drainage basin which averages less than six miles in width and covers about 330 square miles. It has an average slope of about 28 feet per mile. The North Fork tributary of the South Branch has a smaller basin shape factor, a steeper slope (45 feet per mile), and 350 square miles of drainage area.

The North Fork combines with the South Branch immediately upstream of the damsite to form the main stem of the South Branch. The South Fork enters the South Branch near Moorefield.

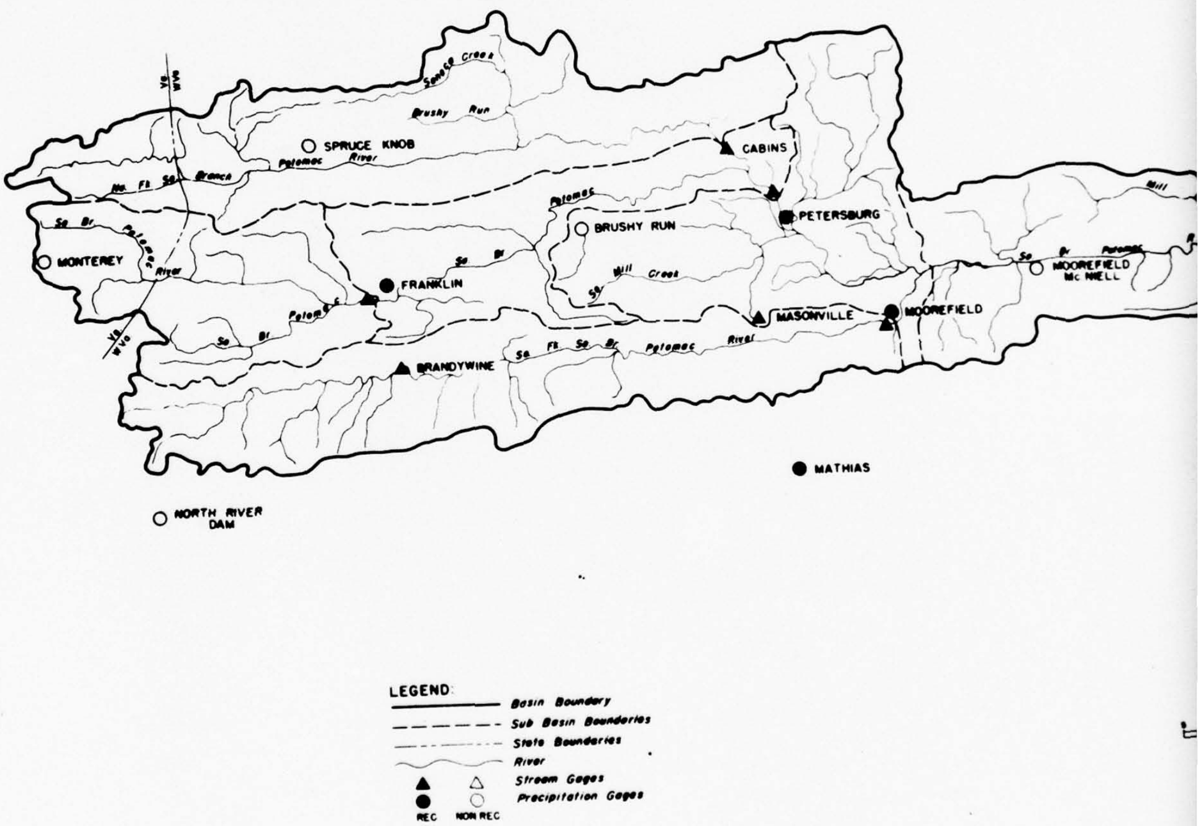
Climatology

The mean annual precipitation for the watershed is about 35 inches as illustrated by the mean annual precipitation isohyetals for the watershed of the South Branch Potomac River above Springfield as shown in exhibit 3-7. Table 3-1 presents average monthly precipitation and average, maximum, and minimum annual precipitation for selected stations. The maximum and minimum amounts of annual precipitation of record for individual stations in the watershed are about 57 inches in 1956 and 17 inches in 1930 at Moorefield, West Virginia. The average annual snowfall is about 38 inches, and the average annual temperature is about 50 degrees. The mean monthly temperatures and snowfalls for selected stations are given in table 3-2. The extremely high ratio of runoff to precipitation which is recorded during the months of February, March, and April (see table 3-4), results from dissipation of the snowpack as a consequence of mild temperatures which terminate protracted low-temperature periods during which there are heavy snowpack accumulations.

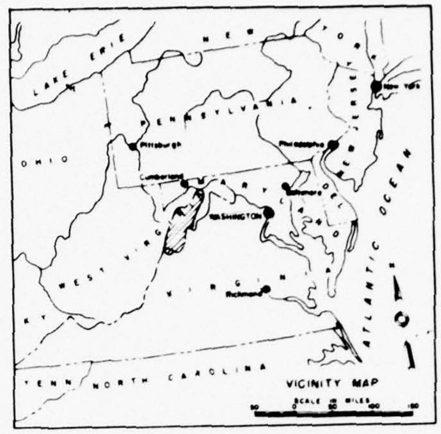
TABLE 3-1
MEAN MONTHLY AND ANNUAL PRECIPITATION

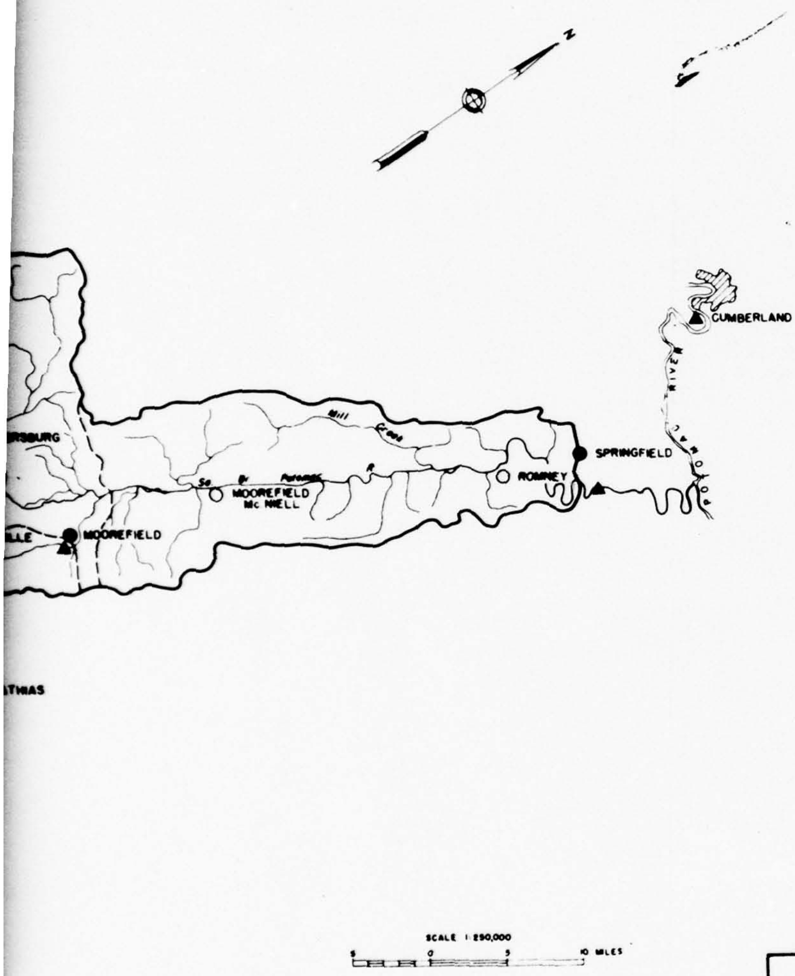
Month	Monterey Va.	Spruce Knob, W. Va.	Moorefield W. Va.	Petersburg W. Va.
January	2.81	3.02	2.19	1.97
February	2.65	2.65	2.00	1.79
March	3.43	3.82	2.62	2.51
April	3.12	3.47	2.64	2.39
May	4.12	5.15	3.30	3.05
June	4.32	4.84	3.79	4.37
July	4.15	5.15	3.30	3.05
August	3.77	5.08	3.25	4.37
September	3.50	3.73	2.39	2.23
October	2.60	3.44	2.28	2.26
November	2.60	2.68	1.74	1.80
December	2.98	2.42	1.99	1.72
Mean Ann.	40.05	45.48	31.54	31.13
No. Yrs. Rec.	20	29	53	22
Ann. Max.	49.90	53.45	57.25	37.47
Year	1942	1937	1956	1952
Ann. Min.	29.07	31.55	16.84	24.86
Year	1946	1953	1930	1957

DEPARTMENT OF THE ARMY



CORPS OF ENGINEERS





COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

GENERAL BASIN MAP

SOUTH BRANCH OF POTOMAC RIVER

Drawn by:________ Approved:____________

Checked by:________ Title:____________

Date:__________

III-3-23 EXHIBIT 3-6

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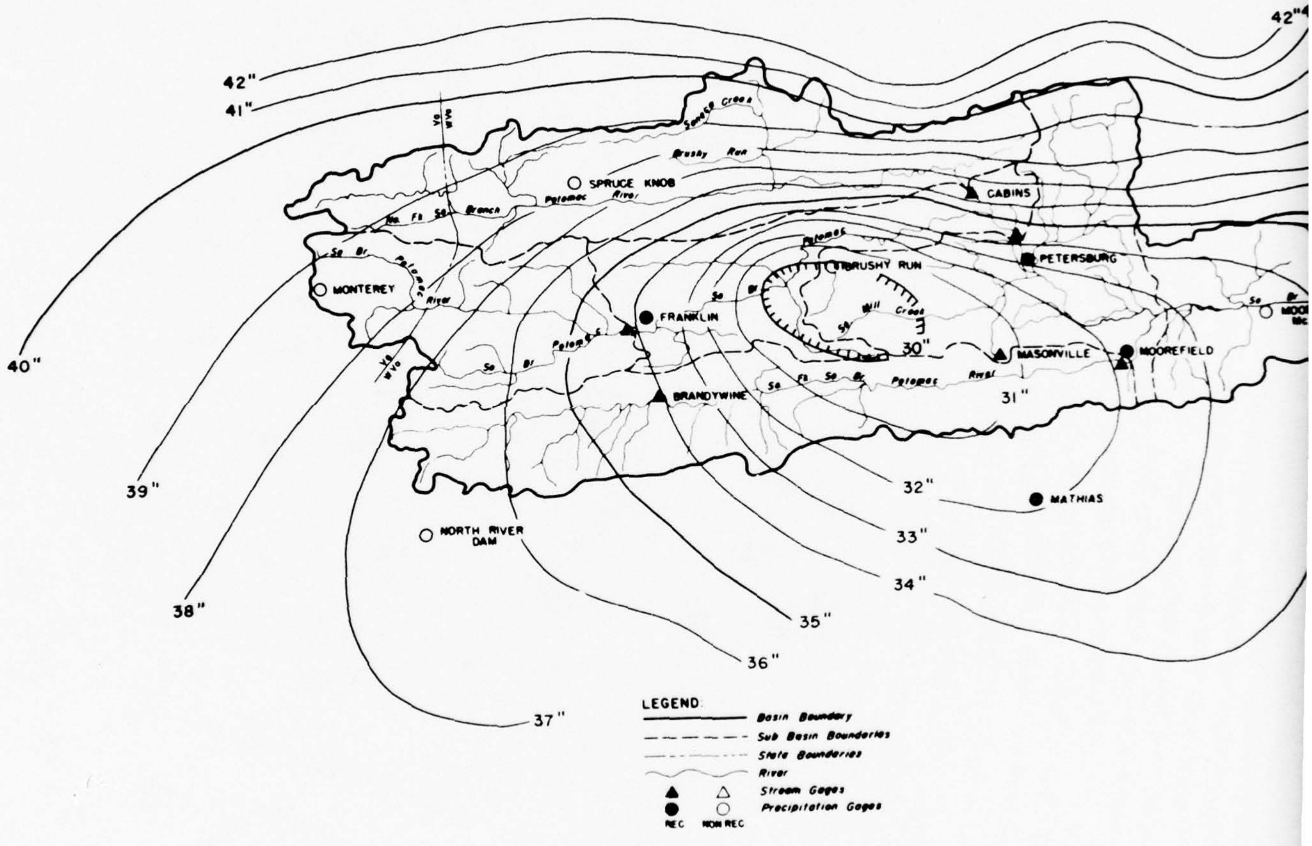
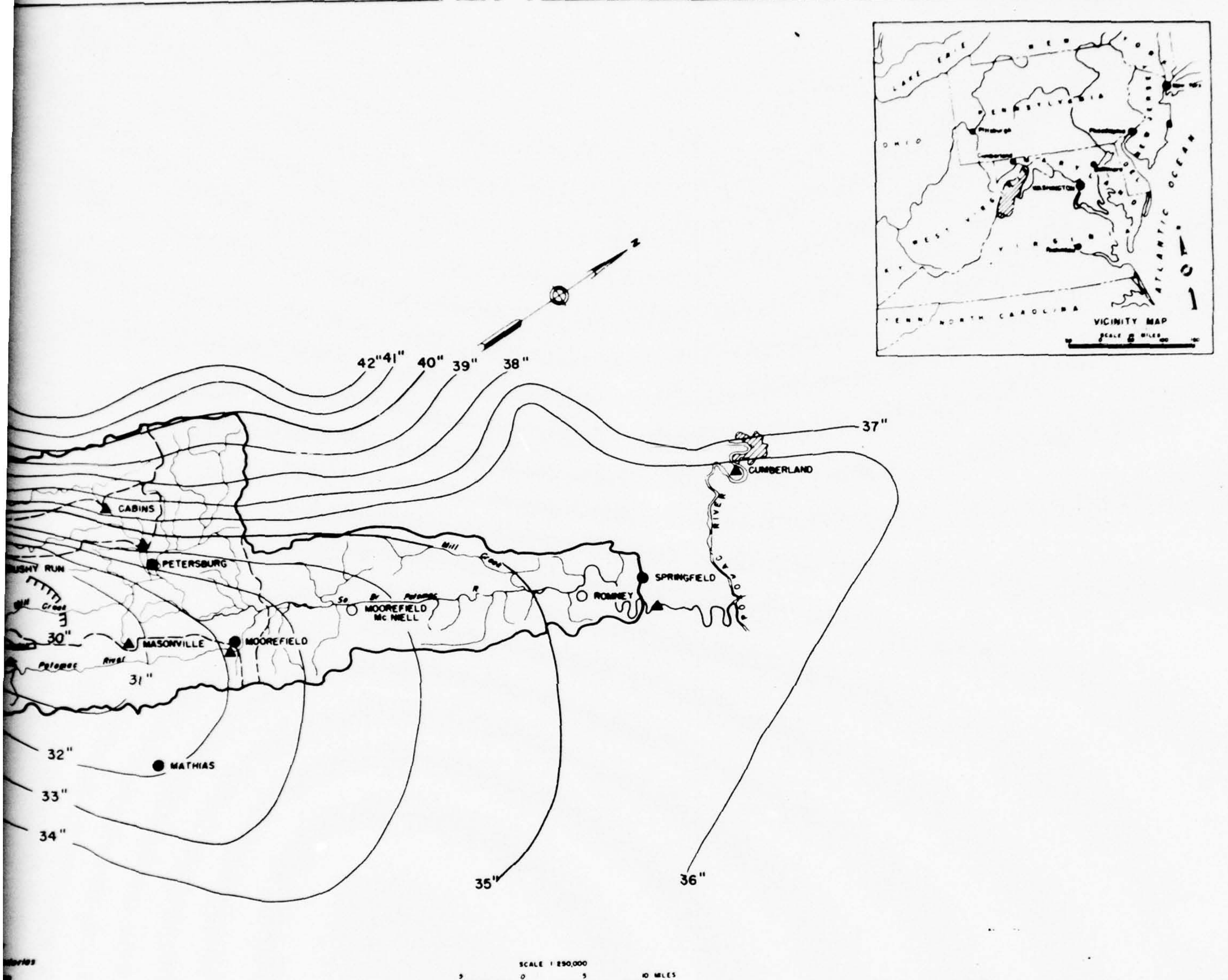
DEPARTMENT OF THE ARMY





COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

SOUTH BRANCH POTOMAC RIVER
ABOVE SPRINGFIELD

AVERAGE ANNUAL PRECIPITATION

Drawn by:________ Approved:________
Title:________
Checked by:________ Date:________

EXHIBIT 3-7

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TABLE 3-2
MEAN MONTHLY TEMPERATURE AND SNOWFALL

Month	Brushy Run Temp (F)	Brushy Run Snow (in)	Moorefield Temp (F)	Moorefield Snow (in)	Spruce Knob Temp (F)	Spruce Knob Snow (in)	Mathias Temp (F)	Mathias Snow (in)
January		6.6	32.5	7.6	28.0	13.2	31.0	5.7
February		5.2	34.3	4.9	29.8	15.6	34.3	7.5
March		6.9	41.4	5.7	33.6	17.6	38.2	10.0
April		0.9	51.8	0.4	47.5	6.3	52.6	2.4
May		0	61.1	T	56.5	0.6	60.7	0
June		0	68.9	0	63.9	0	66.4	T
July		0	72.3	0	67.3	0	71.5	T
August		0	71.1	0	66.7	0	70.1	0
September		0	64.3	0	60.8	T	63.2	0
October		0.2	53.8	T	50.4	0.5	52.1	T
November		1.9	42.7	1.5	38.2	6.2	41.9	2.6
December		3.9	33.2	3.9	29.2	11.6	33.0	3.8
Annual		25.6	52.3	24.0	47.7	71.6	51.2	32.0
Yrs. Record		18	26	19	10	26	9	10

Storms and Floods of Record

Flood-producing storms occur in all seasons of the year in the South Branch Basin. Notable floods occurred in the South Branch Basin in 1899, 1902, and 1924, prior to establishment of stream gaging stations. Official gaging station records at Springfield, Petersburg, and Moorefield began in 1928. The peak discharges of many of the earlier floods at these stations have been adjusted to conform with later slope-area determinations. According to these records, floods of notable proportion occurred in April and October 1929 and a severe flood in February 1932 which was exceeded only by three previously known floods. The August 1933 flood, following a tropical hurricane which caused great damage along the coast, reached higher stages in many of the lower tributaries than the flood of 1936.

The storm of 16-18 March 1936, following a winter marked by protracted periods of low temperatures and heavy snowfall, produced the largest flood of record at Springfield. The rainfall in this storm, following other heavy rains about a week earlier, amounted to 6.45" at Romney and 6.12" at Moorefield.

Severe floods occurred in April and October 1937, February and April 1939, May 1940, May and October 1942, and April 1948. The storm of 11-18 October 1942 followed a tropical disturbance and, while it

caused the largest 24-hour rainfall over the entire Potomac Basin, its effect on the South Branch was not extreme although 6.05" were reported at Romney and 5.04" at Moorefield-McNiell.

The storm of 17-18 June 1949 produced a flood which is recorded as the most severe in the South Branch above Springfield. A maximum 24-hour rain of 12.02" fell on June 18 at Brushy Run, West Virginia, of which 7.84" fell in 12 hours. The total recorded precipitation for the period 16-19 at Brushy Run was 14.26", and at Petersburg 12.42" was recorded; however, the pattern fell off rapidly at lower elevations and only 1.62" was recorded at Springfield. Maximum flood stages were recorded in parts of the South Branch, but the discharge did not reach damaging flood stage on the main stem of the Potomac River.

The storm of 15 October 1954 caused some severe flooding at several stations but no maximum flows were recorded in the South Branch Basin despite recorded rain of 6.10" at Moorefield-McNiell, 4.90" at Petersburg, 5.68" at Franklin and 5.65" at Moorefield.

The Hurricanes "Connie" and "Diane", 11-13 August 1955 and 17-19 August 1955, respectively, precipitated 4.88" and 4.00" at Moorefield-McNeill, 3.45" and 4.25" at Petersburg, 3.10" and 3.08" at Romney and 2.92" and 4.20" at Brushy Run. Flooding occurred following the second storm.

A tabulation of storms and floods is shown in table 3-3. The hypothetical discharges of the standard project and spillway design (probable maximum) floods are included for comparison with recorded flood discharges.

TABLE 3-3

STORMS AND FLOODS OF RECORD SOUTH BRANCH POTOMAC RIVER

Date	Type Storm	Precip. Average	Precip. Duration	South Branch Springfield		South Branch Petersburg		So. Fk. So. Br. Moorefield	
				G.H.	Disch.(cfs)	G.H.	Disch.(cfs)	G.H.	Disch.(cfs)
April 1929		2.8	60 Hrs.	19.13	36,400			7.65	5,700
October 1929		4.7	96 Hrs.	16.33	22,000	12.21	17,600	8.75	7,620
February 1932	V	2.5	60 Hrs.	20.4	37,200	15.18	28,200	7.9	6,570
May 1932		3.3	7 days	17.92	28,200				
August 1933	VI			17.00	28,000	10.2	11,900	10.2	14,000
March 1936	I, II	5.3	4 days	34.2	143,000	20.3	49,800	14.9	30,400
April 1937	I	4.1	4 days	23.0	57,000	10.3	12,200		
October 1937		3.3	72 Hrs.	21.15	46,600	11.66	16,000		
February 1939	II, III	2.8	48 Hrs.	21.40	47,700	14.6	26,000	9.48	12,000
April 1939		2.0	9 days			9.63	13,600		
May 1940		3.8	7 days	20.11	36,100	14.50	25,600	9.42	10,000
16 May 1942		2.4	48 Hrs.	16.58	24,200	13.93	23,500	8.7	11,200
23 May 1942		3.3	72 Hrs.	22.00	51,000	13.70	22,600	11.07	14,600
16 October 1942	VI	4.7	5 days	21.09	46,000		7,200	10.53	12,800
April 1948		2.3	48 Hrs.	17.35	29,400	12.21	17,600	7.11	5,580
June 1949	III, IV	5.4	72 Hrs.	29.85	104,000	22.83	62,000	61.1	39,000
October 1954	VI	5.1	24 Hrs.	21.50	48,200	13.34	21,600	12.14	19,800
18 August 1955	VI	4.8	72 Hrs.	25.55	73,400	12.86	20,300	11.2	17,100
STANDARD PROJECT FLOOD					273,500		123,000		98,100
PROBABLE MAXIMUM FLOOD					405,000		208,000		173,800

STORM TYPES:
- I Stationary Low
- II Secondary Low
- III Secondary Storm Center with Cold Front
- IV Thunderstorms
- V Cold Front
- VI Hurricanes or Tropical Disturbance

G.H. Gage Height

Discharge Records

The drainage area of the South Branch is covered by a stream gaging network of seven stations with records which extend back to 1928. The locations of the stations are shown on exhibit 3-6.

Monthly and Annual Runoff

The annual runoff for the 39-year period of record through the water year 1967 for the Petersburg, West Virginia, gage has varied from 24.22 inches in 1949 to 6.91 inches in 1959 with a mean of about 14 inches. The mean runoff represents about 38 percent of the mean annual precipitation above the gaging station. Mean, maximum, and minimum monthly runoff data are shown in table 3-4.

TABLE 3-4
MONTHLY RUNOFF - SOUTH BRANCH POTOMAC RIVER AT
PETERSBURG, W. VA.
1928 - 1967

Month	Maximum Inches	Maximum Year	Minimum Inches	Minimum Year	Mean Inches	Percent of Mean Precipitation
January	4.23	1937	.33	1940	1.45	58
February	4.67	1939	.34	1934	1.80	79
March	7.34	1936	1.12	1959	2.86	92
April	4.64	1958	.93	1946	2.20	76
May	3.75	1942	.42	1930	1.68	43
June	3.78	1949	.24	1965	.89	21
July	2.66	1949	.13	1966	.51	13
August	2.32	1955	.10	1930	.49	12
September	2.08	1950	.09	1930	.38	13
October	2.84	1938	.09	1931	.49	18
November	1.70	1930	.11	1931	.58	26
December	3.41	1949	.17	1966	.86	38
Annual	24.22	1949	6.91	1959	14.19	38

Historic Floods

The period of continuous record and the period of historical record on South Branch Potomac River are 39 years and 90 years, respectively. Data on floods which occurred prior to the installation of the gaging station at Springfield, West Virginia, are not available excepting that of November 1877. This flood was the second largest known on South Branch and resulted in a peak stage of 34 feet and a peak discharge of 140,000 cfs at Springfield, West Virginia. The

1877 flood is also the largest known flood at Petersburg, West Virginia, and resulted in a maximum stage of 21.2 feet and a peak discharge of 70,000 cfs.

Flood Frequency

Frequency curves for annual peak flows on South Branch Potomac River were developed from station records in accordance with methods presented in the publication "Statistical Methods in Hydrology" by Leo R. Beard, Office of the Chief of Engineers, Department of the Army, January 1962, and "Determination of Flood Frequencies in a Major Drainage Basin" by Harry E. Schwarz, Project Bulletin 59.1 Civil Works Investigation Project CW-152, U.S. Army Engineer District, Washington, January 1959.

Selected peak discharge frequency curves for the South Branch Potomac River are shown on exhibits 3-8 and 3-9.

Unit Hydrographs

A unit hydrograph was derived for the South Branch Potomac River at Petersburg, West Virginia, and is shown on exhibit 3-10. The unit hydrograph at Petersburg (D.A. 642 sq. mi.) is also the adopted unit hydrograph for Royal Glen Dam site (D.A. 640 sq. mi.). The floods of March 1936, October 1942, and August 1955 were selected on the basis of applicability of the derived unit hydrograph to design storm rainfall values.

Standard Project Flood

The standard project precipitation values used in determining the standard project flood for the Royal Glen Project were obtained from studies made by the Weather Bureau and the Office of the Chief of Engineers, for the South Branch Potomac River. The depth-area-duration relationships were approved on 3 June 1958 as a basis for determining standard project floods. The all-season standard project precipitation estimates for the project are essentially the same as would be obtained by the procedures outlined in Civil Engineer Bulletin No. 52-8. The total SPS rainfall is 12.9 inches, and the total rainfall excess is 9.3 inches, assuming an initial loss of 1 inch followed by infiltration losses of 0.05 inch per hour. The SPS rainfall excess was applied to the pertinent 6-hour unit hydrograph for inflow to a full pool, and resulted in a peak inflow of 123,000 cfs. The hyetograph and hydrograph of the standard project flood (SPF) are shown on exhibit 3-11.

Spillway Design Flood

A spillway design storm (SDS) was developed in accordance with procedures outlined in the U.S. Weather Bureau's April 1956 Hydrometeorological Report No. 33. Total rainfall excesses and losses, with an

assumed initial loss of 1 inch followed by 0.05 inch per hour infiltration loss, amounted to 15.3 inches and 4.0 inches, respectively. The rainfall excess was applied to the pertinent 6-hour unit hydrograph and resulted in a peak inflow to a full reservoir of 208,000 cfs as shown on exhibit 3-12. The spillway design flood was routed through the reservoir assuming the initial reservoir level at the conservation pool elevation of 1060 feet msl. The maximum pool elevation, surcharge, and outflow are 1122.0 feet, 5 feet, and 187,000 cfs, respectively, as shown on exhibit 3-12. The outflow through the 126-foot gated spillway would be 158,000 cfs and that through the two 7-foot by 12-foot sluices would be 29,000 cfs.

Spillway Length-Discharge Relation

The spillway design flood was routed through reservoir storage assuming various spillway lengths. Spillway selection was based on the spillway length-reservoir-stage-discharge relations established by these routings. The resulting maximum reservoir stage and spillway discharge relations are shown on exhibit 3-12. The spillway would be a low concrete weir surmounted by three 42-foot wide by 47-foot high tainter gates. The spillway would have a net length of 126 feet with an ogee crest elevation of 1070 feet msl.

Flood Routing Conditions

Reservoir routing computations for the Royal Glen Project were performed by a General Electric 225-8K electronic computer using a spillway rating and flood routing program (Computer Program 22-J2-L210) developed by the Hydrologic Engineering Center of the Corps of Engineers in Sacramento, California. The program computed a spillway rating curve according to the Hydrologic Design Charts of the Waterways Experiment Station, then performed a flood routing of the spillway design flood using the emergency release diagram discussed in Engineering Manual 1110-2-3600. The spillway rating curve is shown on exhibit 3-13.

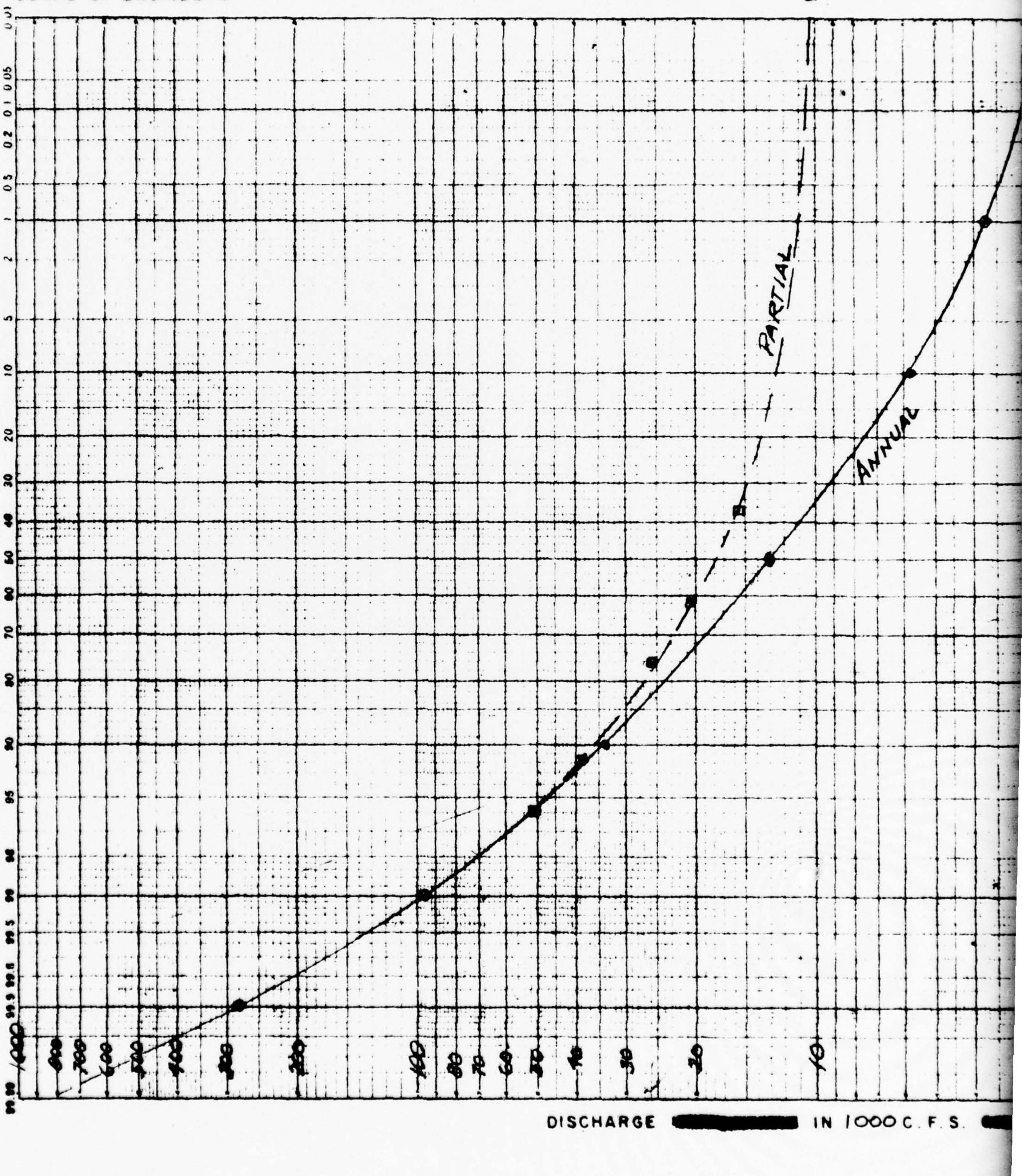
At Beginning of Flood

The spillway design flood for the Royal Glen Project was routed through storage assuming that the reservoir pool level was at the top of the conservation pool (1060 feet msl), and that the standard project flood occurred five days earlier.

Storage Capacity

Area-elevation and capacity-elevation relationships for the Royal Glen Reservoir were prepared by planimetering successive contours on U.S. Geological Survey maps having 20-foot contour intervals and scales of 1:50,000. Area-capacity-elevation relationships corresponding to storage requirements for flood control and conservation (recreation and sediment accumulation) were taken from these

CORPS OF ENGINEERS



DISCHARGE [redacted] IN 1000 C.F.S. [redacted]

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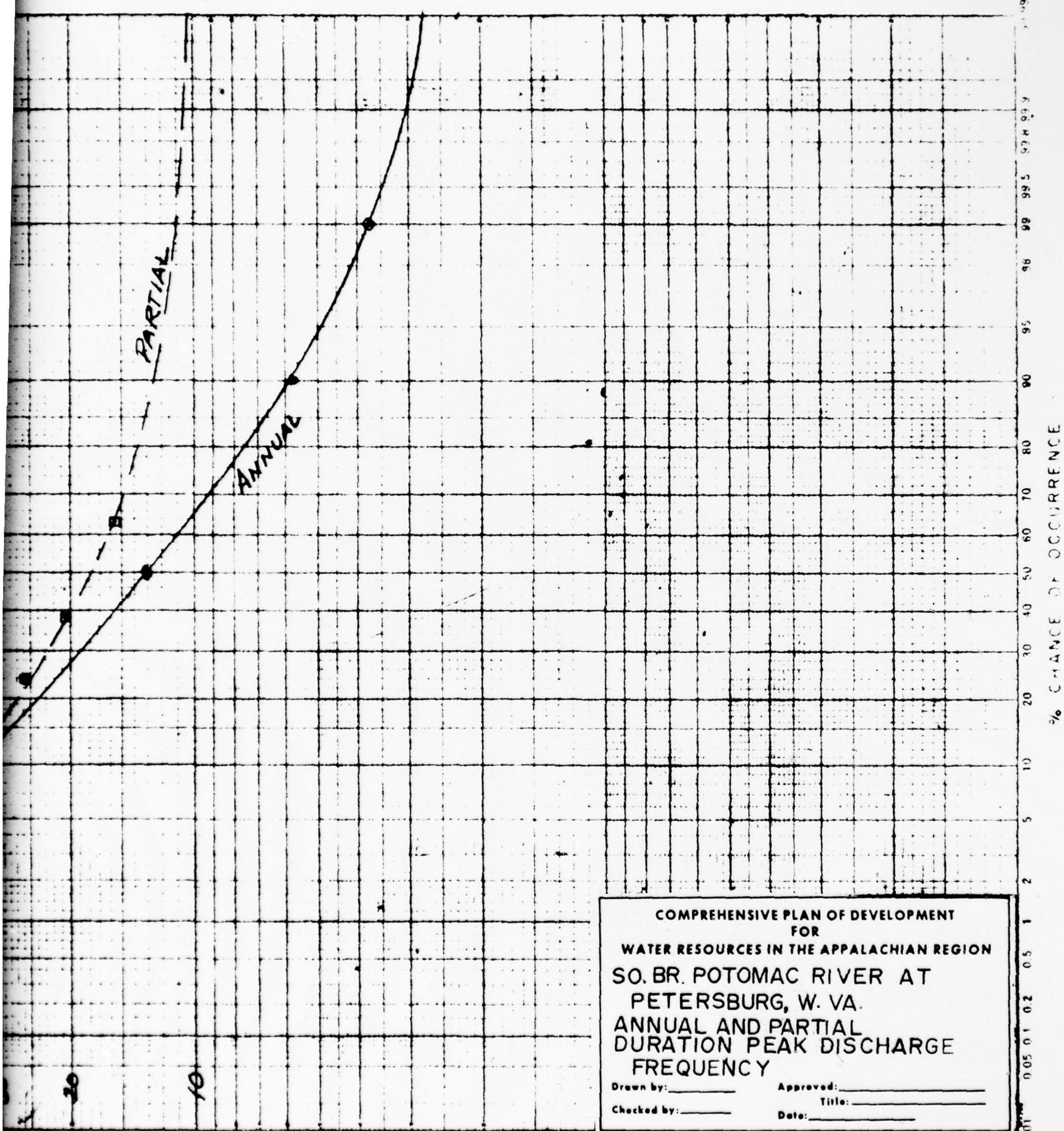
U.S. ARMY



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

SO. BR. POTOMAC RIVER AT
PETERSBURG, W. VA.
ANNUAL AND PARTIAL
DURATION PEAK DISCHARGE
FREQUENCY

Drawn by:________ Approved:________
Title:________
Checked by:________ Date:________

GE [redacted] IN 1000 C.F.S. [redacted]

EXHIBIT 3–8

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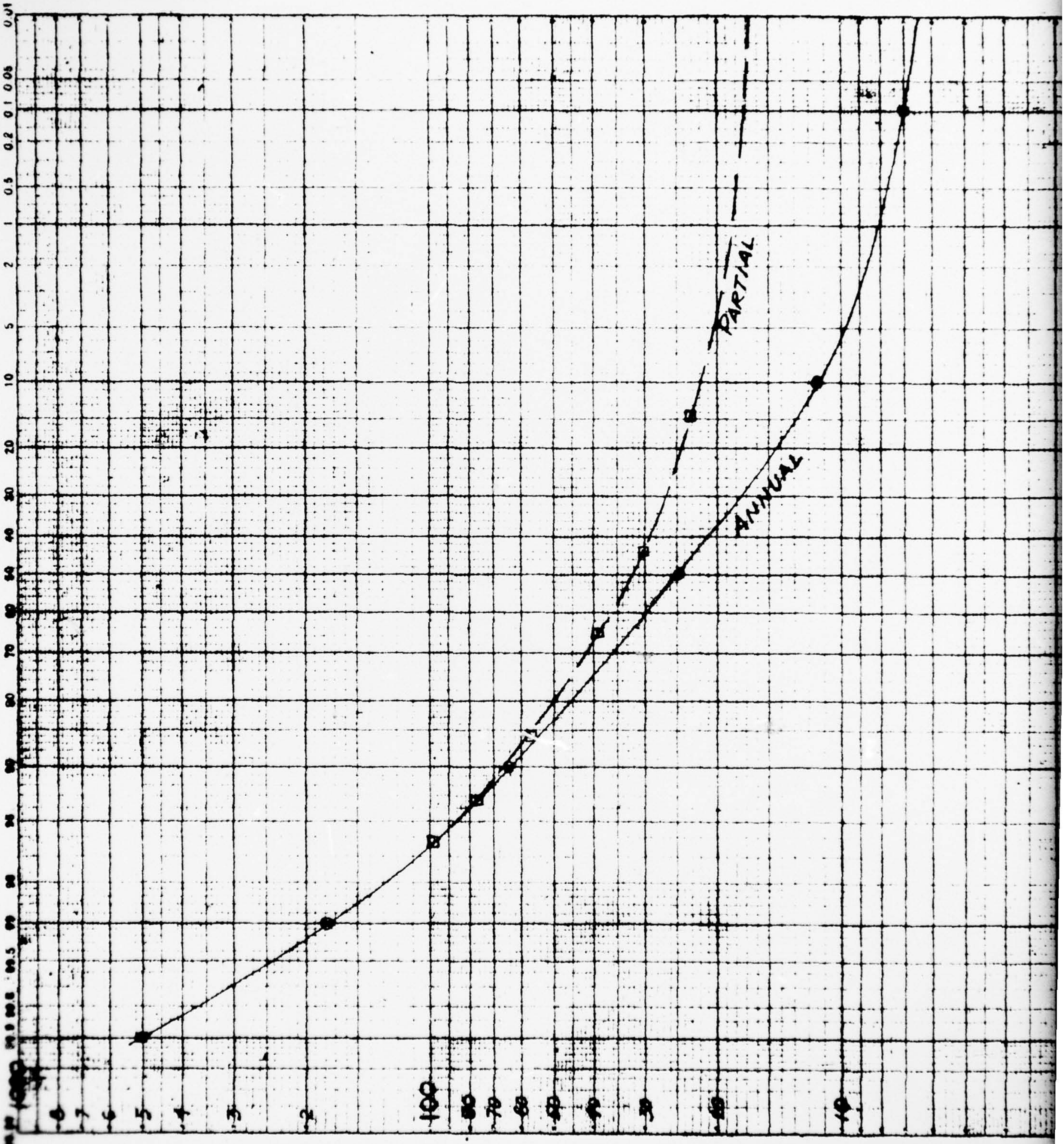

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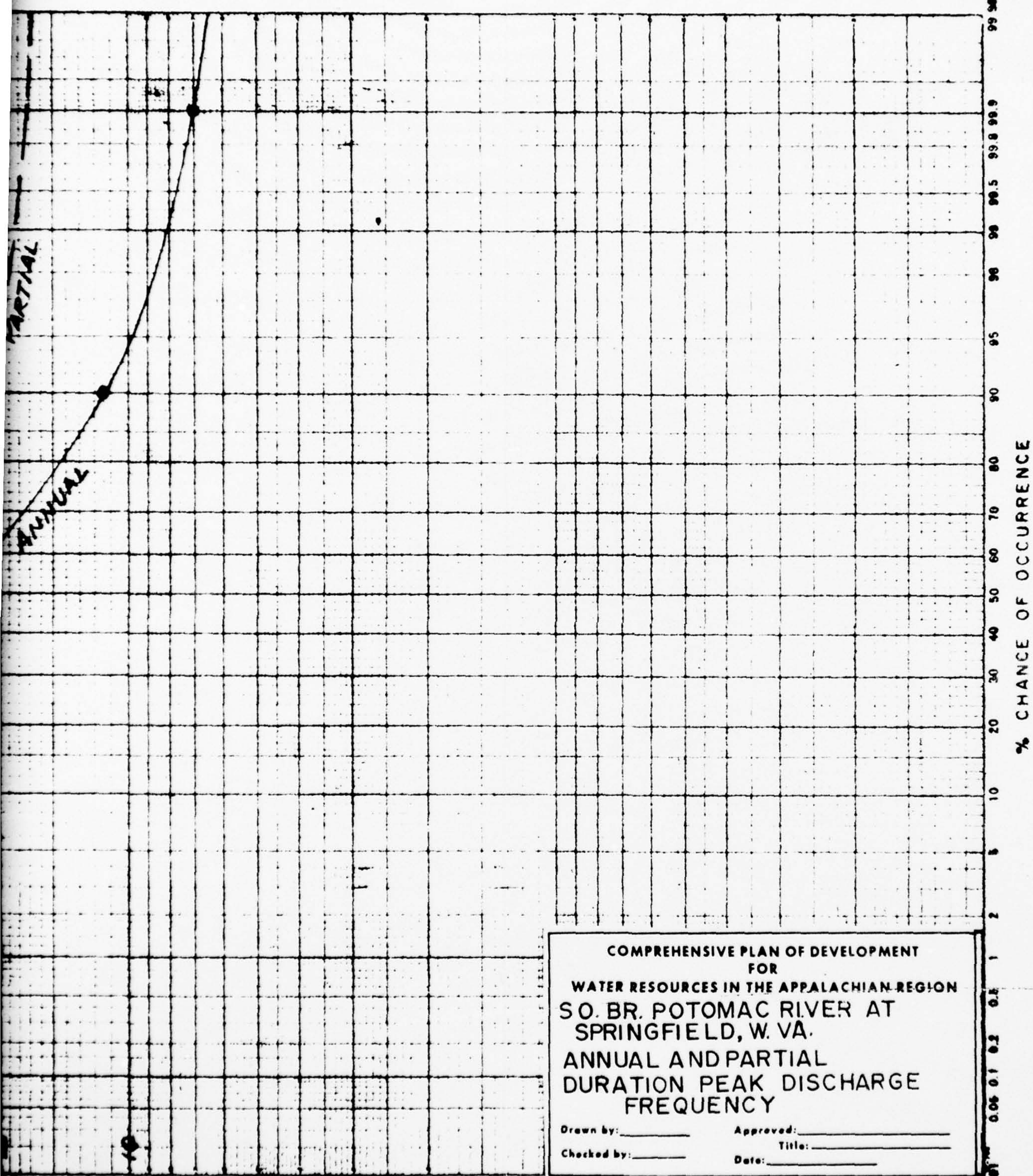

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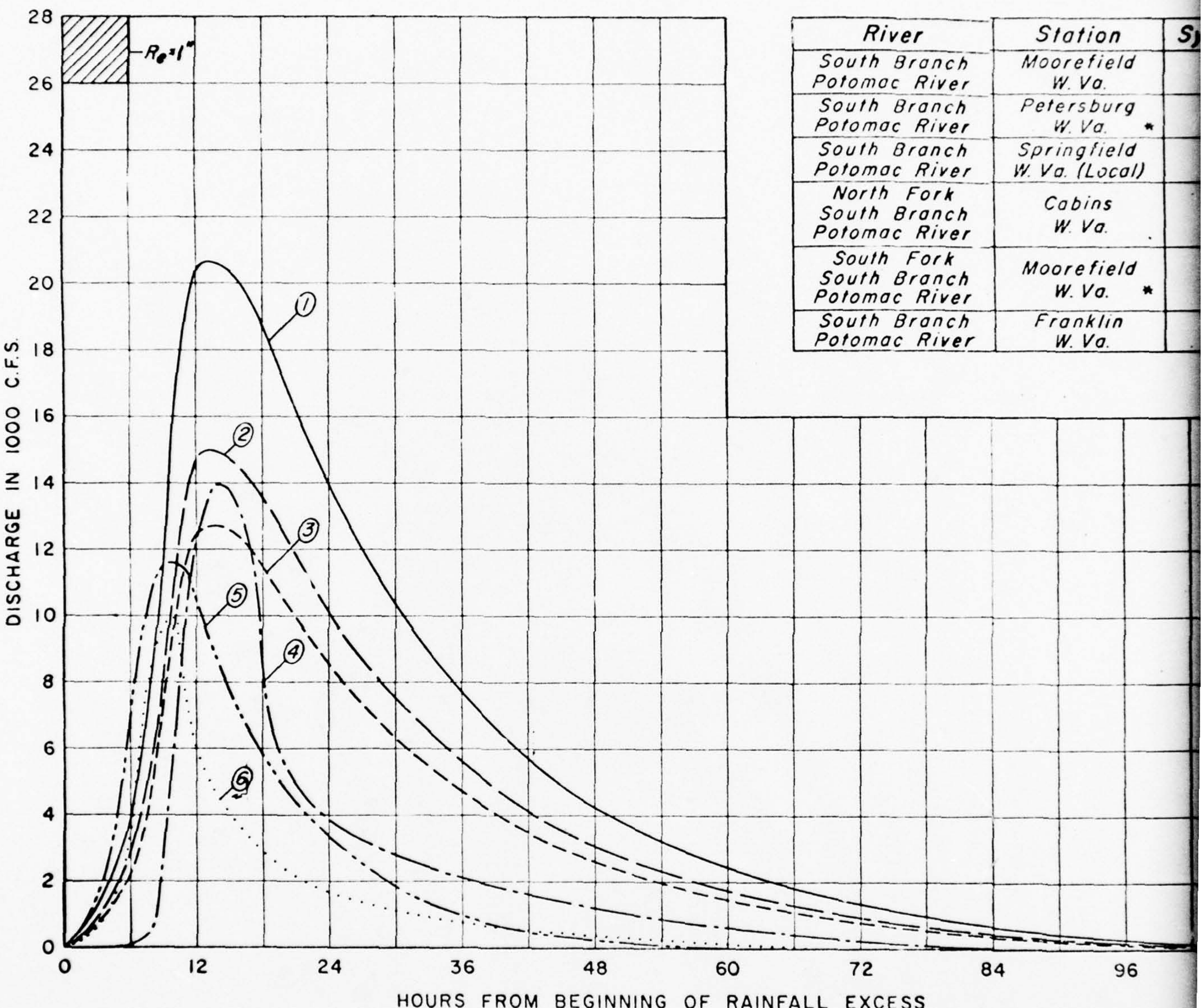
EXHIBIT 3-9



River	Station	Sy
South Branch Potomac River	Moorefield W. Va.	
South Branch Potomac River	Petersburg W. Va. *	
South Branch Potomac River	Springfield W. Va. (Local)	
North Fork South Branch Potomac River	Cabins W. Va.	
South Fork South Branch Potomac River	Moorefield W. Va. *	
South Branch Potomac River	Franklin W. Va.	

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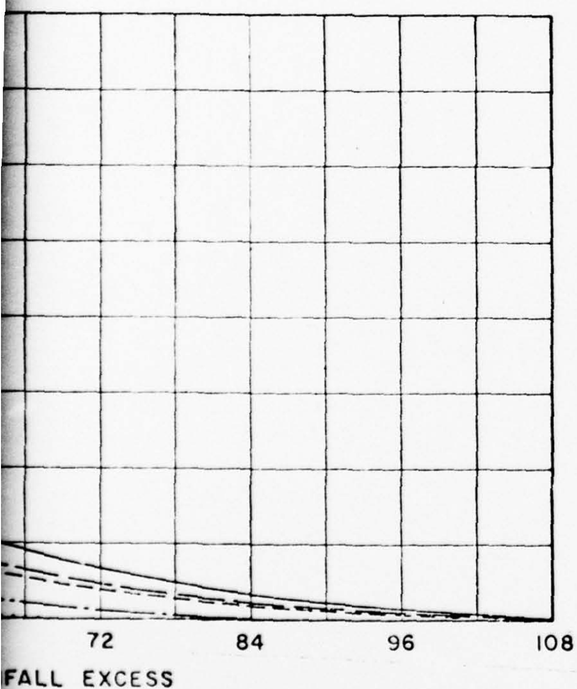
U.S.

River	Station	Symbol	D.A. Sq. Mi.	tp	Qp	Cp 640	C_t R
South Branch Potomac River	Moorefield W. Va.	1	1173	10 Hrs.	20,600	176	0.88
South Branch Potomac River	Petersburg W. Va. *	2	642	10 Hrs.	14,860	235	0.92
South Branch Potomac River	Springfield W. Va. (Local)	3	546	11 Hrs.	12,630	254	0.72
North Fork South Branch Potomac River	Cabins W. Va.	4	314	11 Hrs.	14,000	490	1.13
South Fork South Branch Potomac River	Moorefield W. Va. *	5	283	7 Hrs.	11,650	287	0.71
South Branch Potomac River	Franklin W. Va.	6	182	7 Hrs.	10,000	385	1.23



* Previously Approved
4 th. Ind. OCE. 22 Apr. 1958
Ltr. Wash. DO to NAD
30 Dec. 1957
Subject: Probable Maximum and Standard Project Floods Potomac River at Washington.

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

UNIT HYDROGRAPHS
ADOPTED 6 HOUR

SO. BR. POTOMAC RIVER

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Checked by: ________ Title: ________
Date: ________

EXHIBIT 3-10

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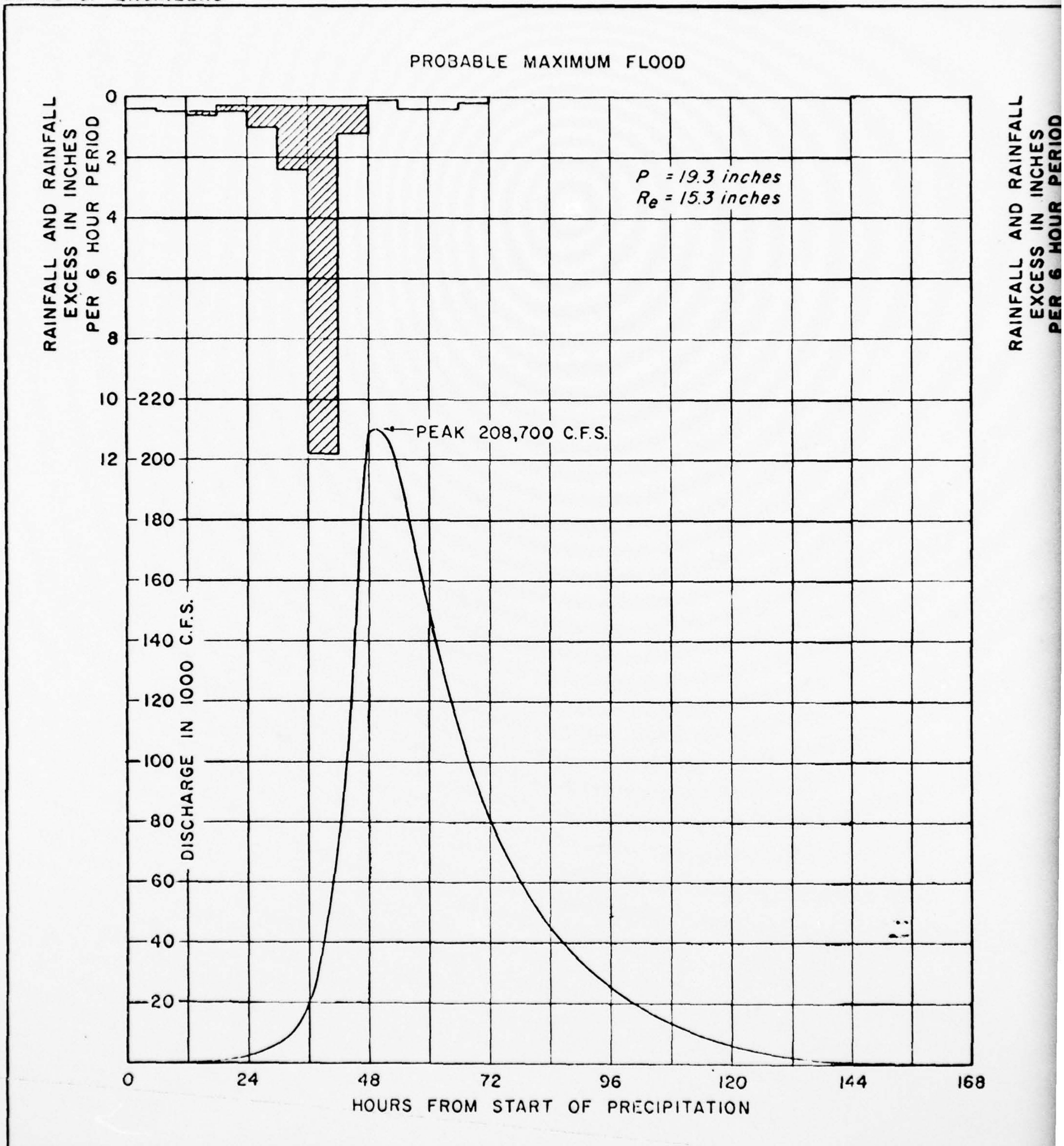

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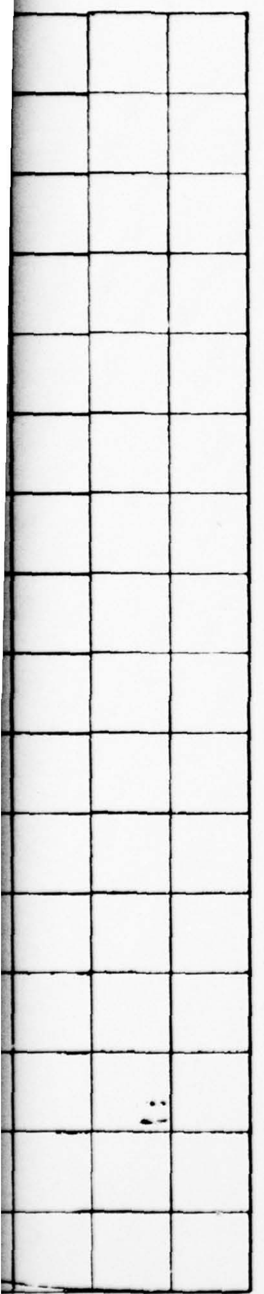

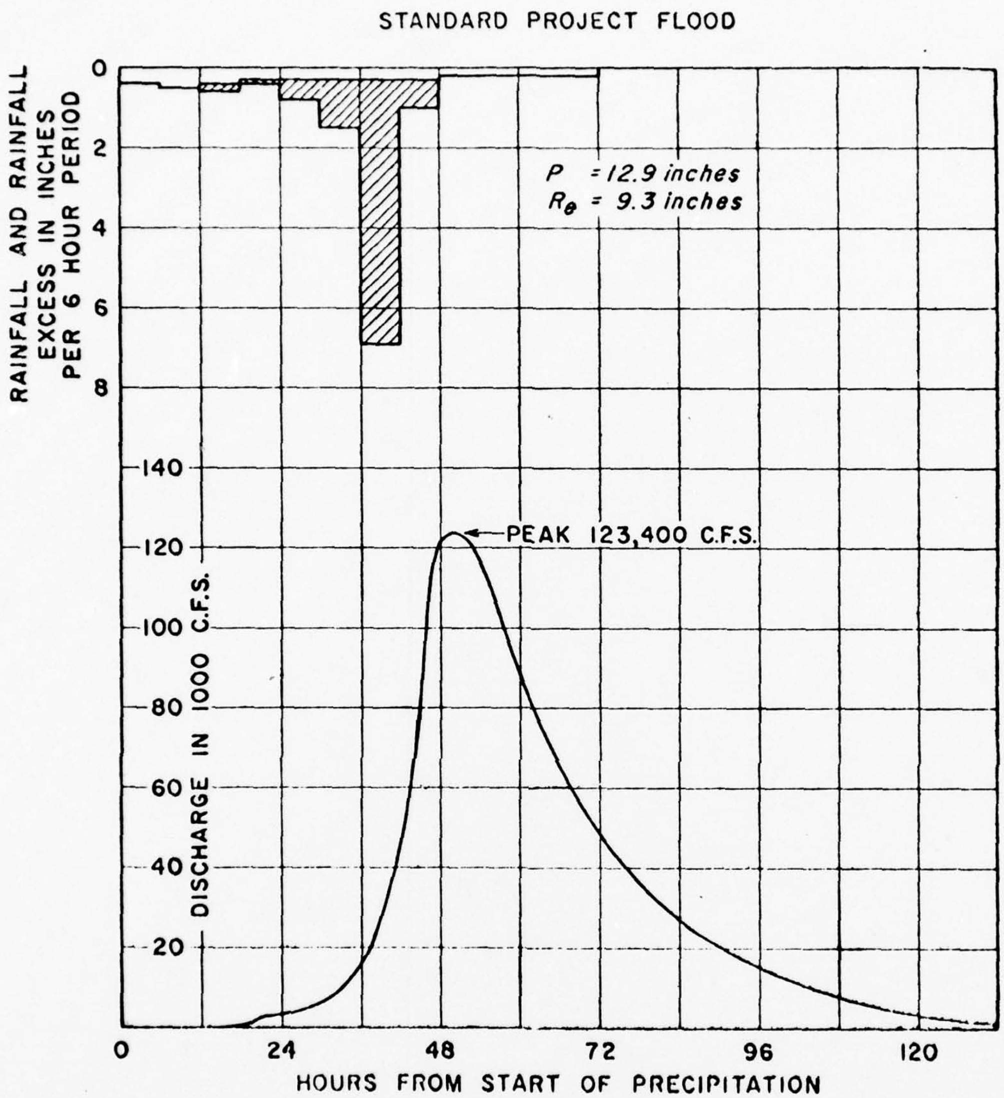

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
STANDARD PROJECT FLOOD
AND
PROBABLE MAXIUM FLOOD
SO. BR. POTOMAC RIVER
AT PETERSBURG, W. VA.

Drawn by:________ Approved:________
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Checked by:________ Date:________

EXHIBIT 3-11

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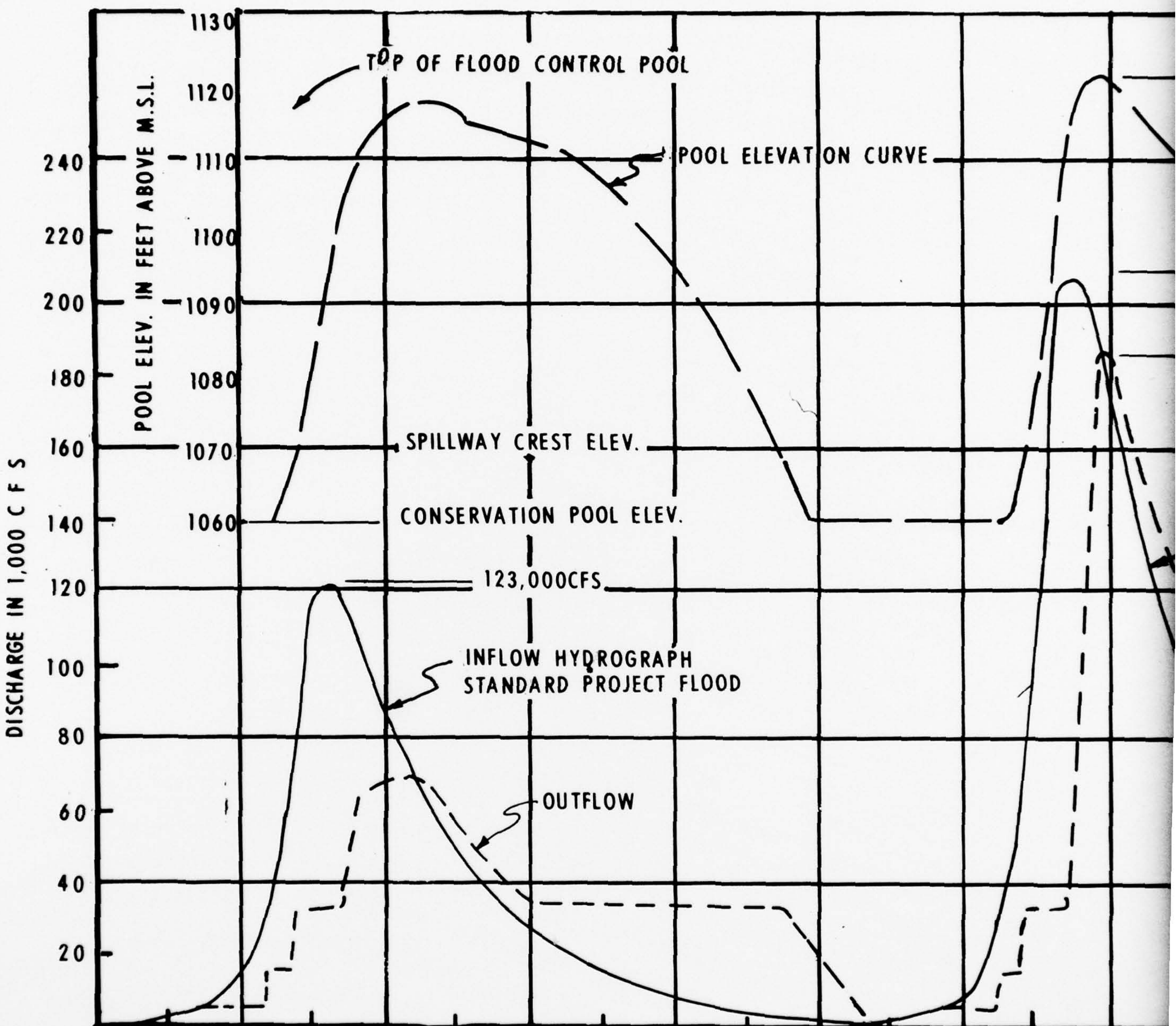

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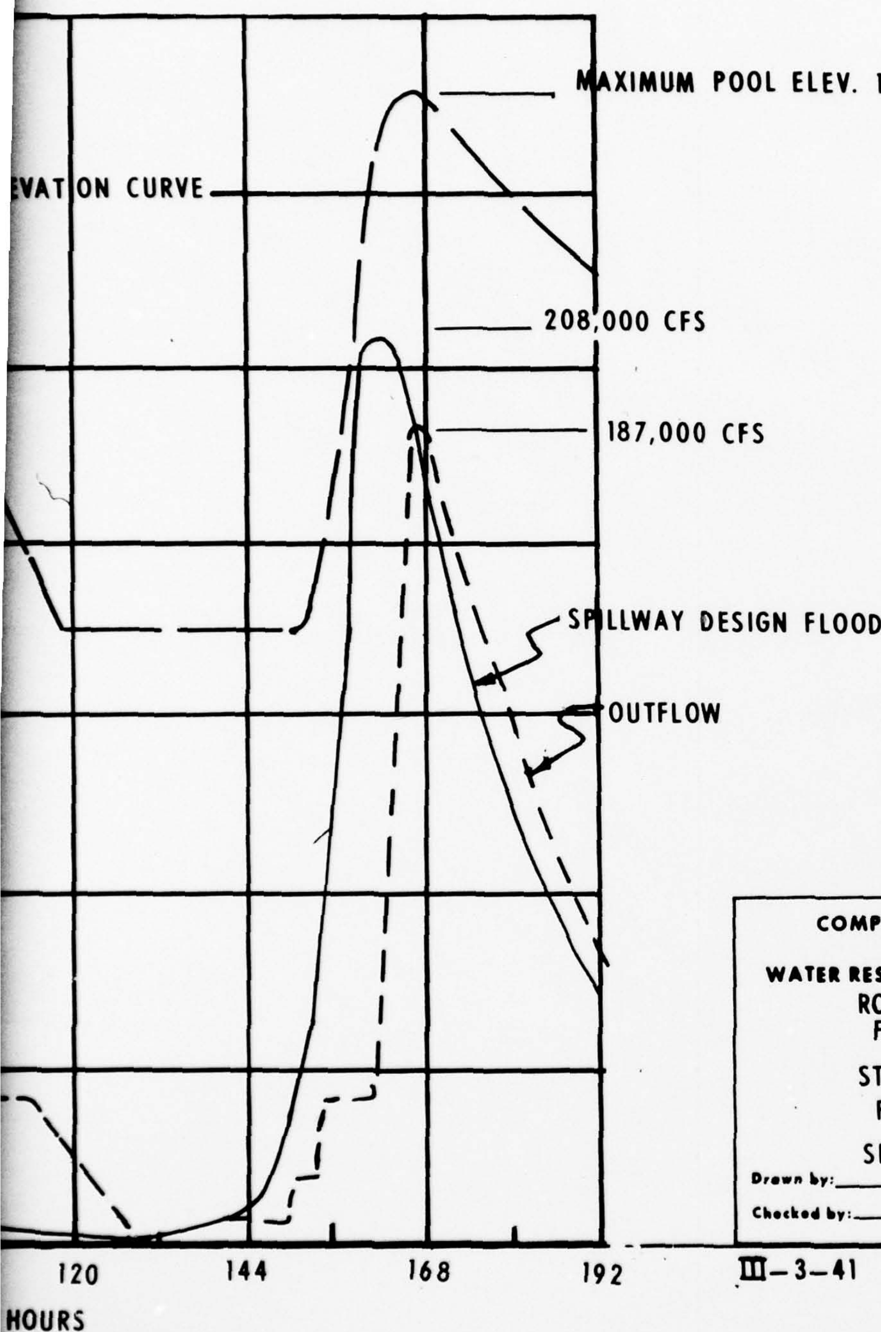

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

ROYAL GLEN RESERVOIR
FLOOD ROUTING OF
STANDARD PROJECT FLOOD
FOLLOWED BY
SPILLWAY DESIGN FLOOD

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Title:________
Checked by:________ Date:________

EXHIBIT 3-12

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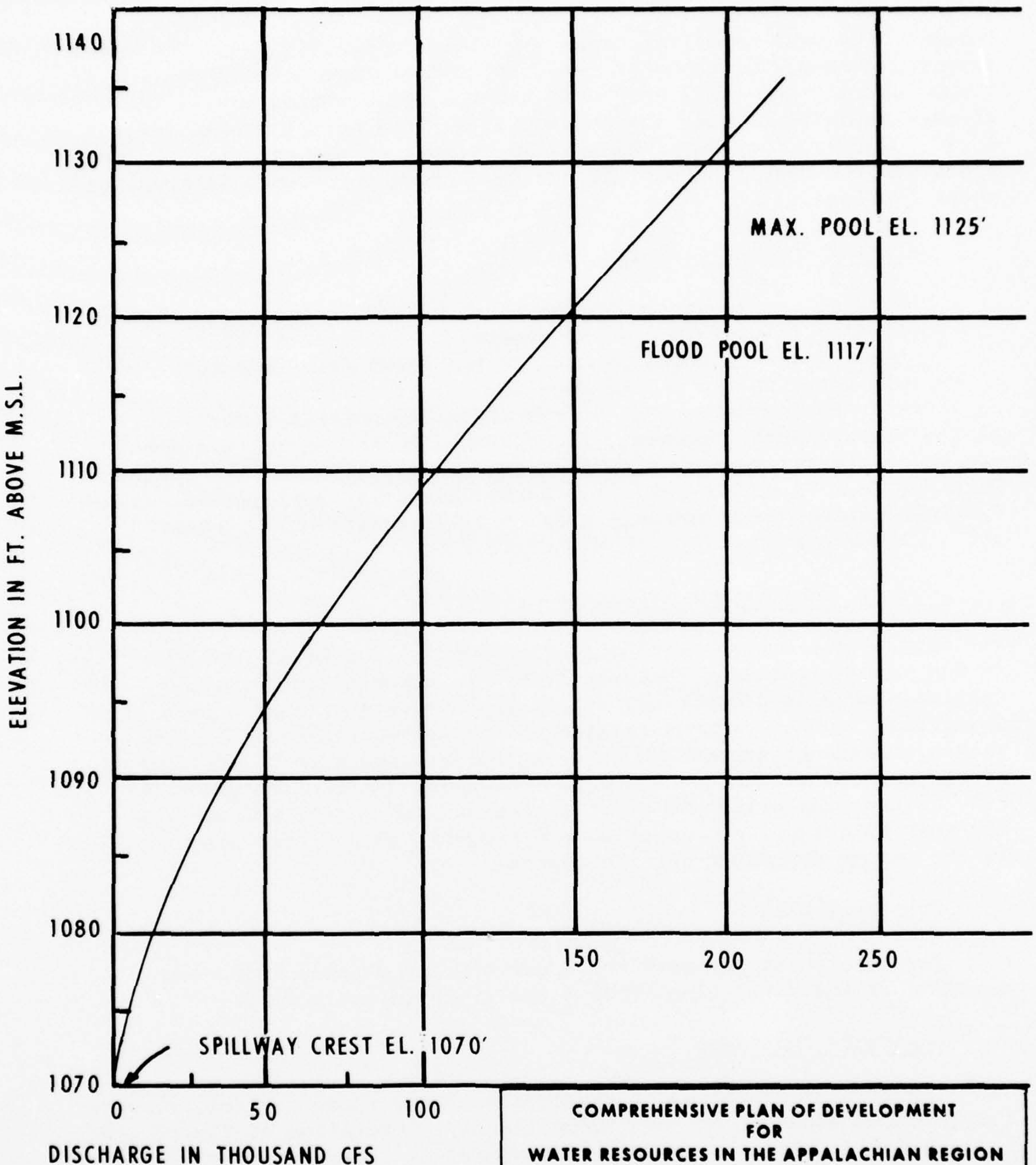


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

ROYAL GLEN RESERVOIR
SPILLWAY RATING CURVE

Drawn by:________ Approved:________
Checked by:________ Title:________
Date:________

 EXHIBIT 3-13

curves. The area-capacity curves are shown on exhibit 3-4. The reservoir provides 2.6 inches of flood control storage between the top of flood control pool (1117 feet msl) and the conservation pool. The storage capacity is adequate to control a flood having a peak inflow of 70,000 cfs. The peak inflow is 50 percent of the standard project flood and the resulting storage has an average recurrence interval of about 50 years.

Existing Channel Capacity

The major damage center in the South Branch Potomac River below the damsite is Petersburg. Flood damages at Petersburg begin at about 15,000 cfs. However, rural damages in the reach from Petersburg to Moorefield occur at flows less than 15,000 cfs. Flood damages at Moorefield are caused by high stages of the Moorefield River as well as the South Branch. However, flood stages of the Moorefield River are being greatly reduced by the present installation of the South Fork Upstream Watershed Project. Rural damages at Springfield, West Virginia, which has a drainage area of 1,471 square miles, begin at about 25,000 cfs.

Channel Improvement Project

Due to the storage limitations imposed on the Royal Glen Reservoir, it was readily apparent that the reservoir alone could not provide the control needed to protect approximately 500 acres of high potential industrial land at Petersburg against the 100-year flood. The most feasible means of augmenting this control was found to be improvement of the channel of the South Branch from about 1-1/2 miles above the U.S. Highway 220 bridge to about nine-tenths of a mile below. The 100-year discharge from Royal Glen Reservoir, 33,000 cfs, was adopted as the design discharge for the channel.

Pertinent Data

Pertinent data for both the reservoir and channel improvement elements of the Royal Glen Project are given in table 3-5.

Reservoir Functions

The primary functions of the reservoir are flood control, recreation, and enhancement of downstream fishery. Operation of the reservoir in conjunction with the channel improvement at Petersburg will provide protection to lands which are presently flooded frequently as shown in exhibit 3-19 (see Para. 20). Conservation storage will provide for recreation and enhanced fishery. Formation of an 1,150-acre body of water at top of conservation pool elevation 1060 will enhance the recreation potential in the upper South Branch Valley. Fishing values downstream in the South Branch will increase as the result of the proposed method of reservoir operation. The Federal Water Pollution Control Administration investigated the need for water supply and water quality storage in the reservoir. Its investigation considered only needs occurring in

TABLE 3-5
PERTINENT DATA
ROYAL GLEN PROJECT

RESERVOIR

Type	Concrete gravity, earth dike
Length, feet	
Concrete section	643
Earth dike	940
Total	1,583
Top width, feet	20
Maximum height, feet	148
Crest Gates	
Type	Tainter
Number	3
Size, W x H, feet	42 x 47
Spillway	
Net length, feet	126
Length of stilling basin, feet	162
Outlet Works	
Sluices, number and size	2 - 7' x 12'
Elevations, feet msl	
Top of dam	1130
Maximum water surface (spillway design flood)	1122
Reservoir clearing	1063
Top of Spillway crest gates	1117
Full conservation pool	1060
Spillway crest	1070
Outlet works, invert	985
Streambed at dam	982
Storage, acre feet	
Static flood control	90,000
Conservation (Recreation and Sediment)	38,000
Total	128,000
Area, acres	
At maximum water surface	2,100
At full conservation pool	1,150

CHANNEL

Channel Improvement	
Length, feet	12,800
Minimum Bottom Width, feet	300
Side Slopes	3 Horizontal to 1 Vertical

Appalachia. No need was found for reservoir storage for water supply and water quality control in the South Branch Potomac River.

Reservoir Regulation

The Royal Glen Reservoir would be operated for reduction of floods, primarily at Petersburg. Flood control operation would be primarily in the interest of non-damaging channel discharge capacities, as well as for more general flood control in the downstream reaches of the South Branch Potomac River. Regulation for flood control will be based on inflow, reservoir elevation, and flow in the South Branch at downstream damage centers. Due to the limited flood control storage available in Royal Glen Reservoir, it would not be possible to withhold releases until flooding conditions subside at all downstream locations. There would conceivably be occasions when the necessity for recovery of the project's flood control capability and avoidance of prolonged inundation of areas adjacent to the reservoir may require initiation or increases of releases prior to complete recession of floods from the uncontrolled drainage area.

However, for all floods, reservoir releases under the proposed regulation would not be higher than the natural peaks would have been at the damsite. To reduce flood damages between Petersburg and Moorefield, the reservoir would be operated to release 5,000 cfs when reservoir inflows were below 25,000 cfs. For larger inflows, the releases would be limited to the non-damaging flow for urban areas immediately downstream from the damsite, 15,000 cfs, as long as possible, after which releases to 33,000 cfs would be made so as to most effectively use the available flood control storage in reducing peak outflows and to take full advantage of the channel capacity at Petersburg during floods in excess of the 50 year flood.

For conservation purposes, fishery enhancement and recreation enhancement would be major factors in the determination of project non-flood releases. The conservation regulation of the Royal Glen Reservoir would be made to maintain 100 cfs minimum flow year round and 360 cfs minimum flow during April and May. Adjustments of this operation plan to optimize reservoir recreation values and downstream fishery values will be made during detailed planning or during actual operations as necessary.

Reservoir Operation

During the summer months the demand for a stable pool to maximize recreation benefits will reach its zenith. Since Royal Glen Reservoir is proposed as a multipurpose project, operational plans have been formulated to accomplish the primary purposes with the minimum destruction of the natural aesthetic values.

Analyses of Low Flow Periods

A cursory review of the "Compilation of Records of Surface Waters of the United States," Part 1-B, U.S. Geological Survey, reveals that the average monthly flows at Petersburg were less than 71 cfs during each of the 5 months, July through November, 1930. The average for this period was about 58 cfs. During the period of July, 1928, through September, 1960, there were 31 months with average flows less than 100 cfs, and 64 months with average flows of 100 to 200 cfs. The minimum daily flow recorded was less than 100 cfs for each year of this 32-year period, except 1949 when the minimum daily flow was 152 cfs.

Effect of Reservoir During 32-Year Period

Royal Glen Reservoir would have been operated at the top of the conservation pool, elevation 1060, insofar as variations in inflow would have permitted.

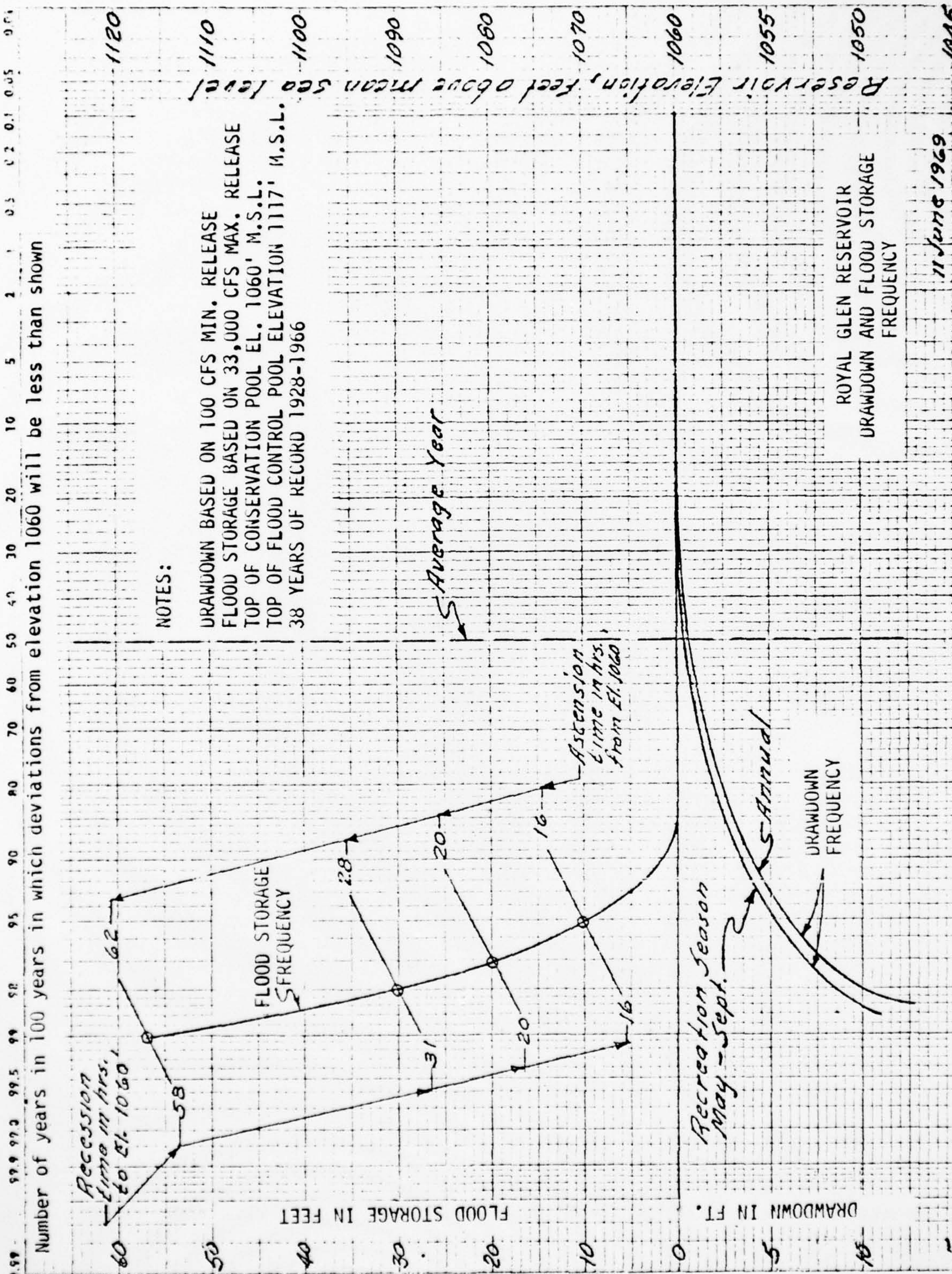
Royal Glen Project, as proposed, would have virtually eliminated flood damages at Petersburg and substantially reduced damages for many miles below Petersburg during the period of record since the gaging station was established in 1928. During non-flood periods the release from the reservoir would have been equal to the inflow (except for evaporation) to maintain the full pool elevation so long as the inflow exceeds 100 cfs (360 cfs during April and May). Whenever the inflow is less than 100 cfs, water will be withdrawn from storage to maintain a minimum outflow of 100 cfs (and 360 cfs during April and May). Except for temporary storage of excessive flood runoff, with subsequent evacuation of the flood storage at the earliest feasible time, the streamflow regimen will not be significantly altered during periods of high and median flows.

Replenishing the depleted reservoir storage would not pose a problem or necessitate a significant dimunition of the natural flows. The storage depletion would be only about 5,300 acre-feet. Retention of a small portion of the inflow of January (429 cfs), February (376), and March (1,485) 1954 would replenish the conservation pool without noticeable reduction of flows at downstream locations. Inasmuch as this drawdown, about five feet, occurs in winter it is inconceivable that there would be a serious impairment of the limited recreation activities or adverse effect on the fish population of the reservoir, although the drawdown would probably inconvenience some recreationists if it had occurred in mid-summer.

Exhibit 3-14 shows the anticipated frequency of storage in the flood control pool and drawdown of the conservation pool.

Reservoir Regulation Effects

The Royal Glen Reservoir effects on flood flows at downstream locations were determined by flood routing for three basin-wide floods.



Number of years in 100 years in which deviations from elevation 1060 will be less than shown
Reservoir Elevation, feet above mean sea level
NOTES:
DRAWDOWN BASED ON 100 CFS MIN. RELEASE
FLOOD STORAGE BASED ON 33,000 CFS MAX. RELEASE
TOP OF CONSERVATION POOL EL. 1060' M.S.L.
TOP OF FLOOD CONTROL POOL ELEVATION 1117' M.S.L.
38 YEARS OF RECORD 1928-1966
ROYAL GLEN RESERVOIR
DRAWDOWN AND FLOOD STORAGE
FREQUENCY
11 June 1969
FLOOD STORAGE IN FEET
DRAWDOWN IN FT.
FLOOD STORAGE FREQUENCY
DRAWDOWN FREQUENCY
Average Year
Annual
Recreation Season May-Sept.
Recession time in hrs. to El. 1060
Ascension time in hrs. from El. 1060

AD-A041 392 CORPS OF ENGINEERS CINCINNATI OHIO F/G 8/6
DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)
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These are the reconsti d floods of October 1942 and March 1936, and the standard project ıood above Washington, D.C. Table 3-6 gives the effects of the reser ir on stage and discharge at downstream damage centers. The Royal Glen Project would reduce the average annual flood damage in Petersburg by over 90 percent, and in the South Branch Valley by about 70 percent.

Sediment

Sedimentation studies made by the U.S. Geological Survey indicated annual sediment inflows vary from about 30 tons per square mile to 220 tons per square mile in the Potomac River Basin. The extensive forest cover of the watershed will preclude excessive sediment production. The estimated 100-year loss of storage due to sediment deposition would be equivalent to about ten percent of the conservation storage. In addition, the proposed USDA's So h Branch Upstream Watershed Project currently being planned and the recommended accelerated land treatment pı am for the drainage area above Royal Glen project will further reduc diment production.

Freeboard Requirement

The freeboard requirement, computed in accordance with ETL 1110-2-8, would be less than five feet. However, in order to provide additional clearance between the tainter gates and the access bridge across the spillway, the top of the dam was established at elevation 1130.

Acquisition Guidelines

Due to the steepness of land slopes alongside the reservoir, the criterion of acquisition to a minimum distance of 300 feet horizontally from the 1117 contour will generally govern. However, at locations where acquisition to the 1122 contour would result in the taking of a larger area, this would prevail.

TABLE 3-6
FLOOD CONTROL EFFECTS
ROYAL GLEN RESERVOIR

Location	Natural Peak Discharge (cfs)	Natural Peak Stage (ft.)	Modified Peak Discharge (cfs)	Modified Peak Stage (ft.)
		Flood of March 1936		
South Branch, Potomac River near Petersburg, West Virginia	55,000	20.8	15,000	11.0
		Flood of October 1942		
	7,100	7.5	6,000	6.3
	Standard Project Flood above Washington, D.C.			
	9,000	8.5	5,000	6.3

Hydrologic Network

The drainage area of the South Branch is covered by a stream gaging network of seven stations with records which extend back to 1928. In the South Branch Potomac River Basin below the Royal Glen Dam site, stream gaging stations are maintained near Petersburg and Springfield, West Virginia. Several rainfall stations are also located within the drainage basin. Additional stations necessary for efficient operation of Royal Glen Reservoir would be sited and installed in cooperation with the USGS and USWB.

11. GEOLOGIC

Surrounding Area Description

The project site is in the physiographic region known as the Valley and Ridge province. This province extends eastward from the Allegheny Front to the Blue Ridge Mountains and is the largest of the regions constituting the Potomac River Basin. All of the sub-basins drained by the tributaries that enter the main stem between Cumberland, Maryland, and Harpers Ferry, West Virginia, are in this province. The most important tributaries of the division enter from the south and are the South Branch, Cacapon, and Shenandoah Rivers. The principal northern tributary is Conococheague Creek.

Area Geology

The Valley and Ridge province consists of intensively folded and, in many places, faulted, sedimentary rocks that range in age from Cambrian to Devonian. Deep dissection, controlled by parallel orientation and regular repetition of similar folds, has resulted in the development of a series of roughly parallel ridges and valleys with northeasterly-southwesterly trends. The more resistant sandstones form the ridges and the less resistant shales and limestones form the valleys. The Potomac River, an antecedent stream, has held its general southeasterly course from Cumberland to Harpers Ferry across the folds, while its tributaries have established their courses in consequence of the folds and flow parallel to them. The western two-thirds of the area in which the Royal Glen site lies is characterized by comparatively narrow, parallel ridges and valleys. The dominant rocks of the valleys are Devonian shales while Devonian and Silurian sandstones generally form the crests of the ridges. A series of limestones belonging to the Helderberg formation is also present in many of the ridges and valleys, therefore, problems in subterranean drainage are by no means absent.

Altitudes in the Valley and Ridge area range from a low of about 250 feet msl at the mouth of the Shenandoah River to a high of around 2500 feet msl along the highest ridges. In general, topographic conditions in this province are highly favorable to reservoir development.

General Project Description

The Royal Glen Dam site is located on the South Branch Potomac River in Grant County, West Virginia, just below the junction of the North Fork and the South Branch (see exhibit 3-1). Here the river enters and flows for a distance of about one mile in a narrow valley formed in resistant sandstones and cherty limestones that form precipitous slopes on both sides. At the damsite, the stream has cut its bed to elevation 982 feet msl, and is near bedrock. Comparatively narrow spur ridges with steep riverward slopes form the abutments. The left bank ridge has a top elevation of about 1220 feet msl, with a shallow saddle 500 feet back of the bluff. The right bank ridge rises to elevation 1220 feet msl. The width of the valley at the edge of the bluffs is about 650 feet.

Site Geology

Exhibit 3-3 shows the extent of geologic investigations in the project area and the geologic profile is shown on exhibit 3-15. The narrow section of the valley, which extends from the junction of the North Fork and the South Branch to Royal Glen Mill, a distance of anticlinal and synclinal folds. The anticlines formed by Oriskany sandstone and cherty Helderberg limestone make the ridges, and the synclines formed of Romney shale make the valleys. The farthest upstream anticline of this series forms the damsite. This fold is almost a perfect arch

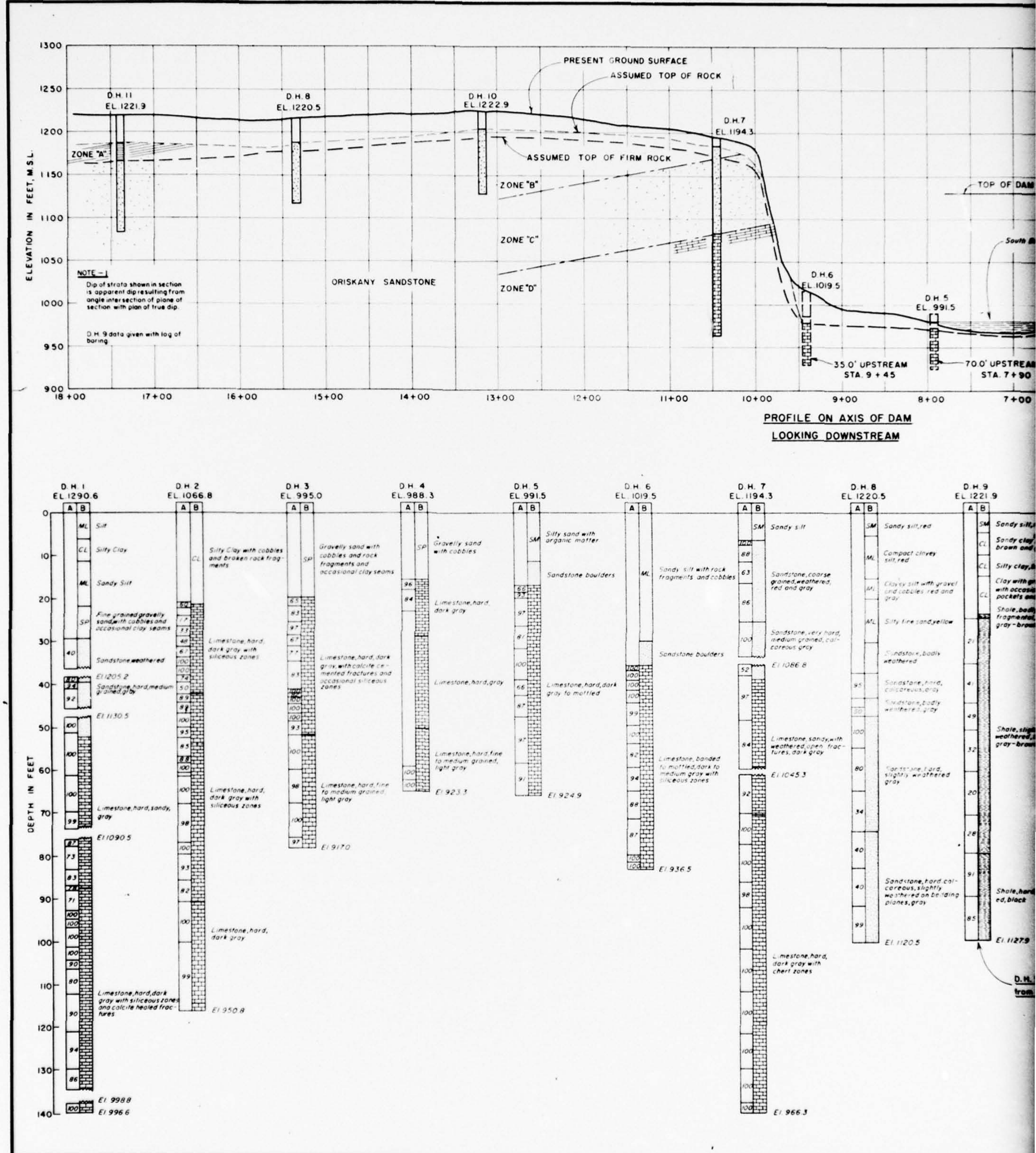
with a width at the valley floor of about 1,000 feet. Its axis strikes N 40 E making an angle with the eastward flowing stream of about 45 . It plunges to the northeast with the result that a given stratum occurs lower in elevation at the crown of the arch in the left abutment than in the right abutment. It would have been preferable to have located the axis of the dam on the upstream limb of the fold had the skewed position of the fold with respect to the stream course not made such a location impracticable. The rocks forming the fold are Oriskany sandstone and Helderberg limestone, both of the Devonian Age. The Oriskany sandstone caps the abutment ridges and forms their flanks. Its northeasterly plunge carries it beneath the Romney shale some 600 feet northeast of the left abutment in the saddle area. It also dips under the Romney shale on the east flank of the ridge. This sandstone has two members; an upper, coarse-grained, rather porous sandstone and a lower, hard, fossiliferous sandstone. The Helderberg formation is, perhaps, as thick as 500 to 600 feet. The upper 200 feet of it, which is related to the construction of a dam, consists of three fairly distinct types of limestone. These have been designated in descending order as the "D" (see exhibit 3-15), "E", and "F" members. The "D" member is about 50 feet thick and consists of hard, sandy limestone. The "E" member is approximately 120 feet thick and consists of cherty, argilaceous limestone. The "F" member is rather pure, light-grey limestone. No cavernous structures were found in any of the borings. The scale of exhibit 3-15 does not permit display of the "E" and "F" members. However, cavernous conditions are characteristic of this type of limestone and have been considered as possible within the abutments. The valley fill consists of silt, sand, gravel, and fragmental rock, becoming bouldery adjacent to the abutments where blocks of rock have slid off the walls. The fill thickness varies from a few feet in the streambed to possibly 30 to 40 feet along the toe of the valley walls. No faulting was recognized in the damsite area; however, there is a thrust fault of considerable displacement immediately downstream of the site. This fault accompanied the folding and resulted in a sharp break and displacement of the strata in the first anticline below the damsite. The fault crosses the river about 800 to 900 feet below the axis of the dam, and should in no way affect the stability of the dam.

A small dike is required to close the reservoir along the saddle connecting the damsite ridge with Knobley Mountain to the west. This low-saddle ridge, forming the northeast divide of the reservoir, is underlain by the relatively impervious Romney shale. Seismic tests were made in the low saddles along the dike for the Plan for the Development of the Potomac River Basin, Corps of Engineers, 1963.

Subsurface Investigation

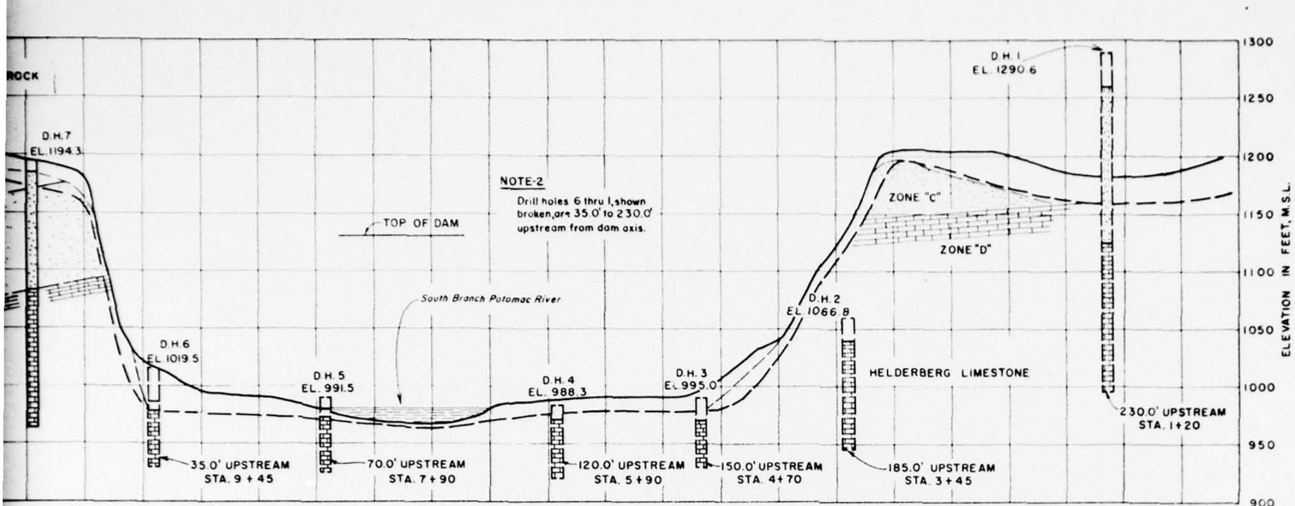
Eleven core borings were made by the War Department, U.S. Engineering Office, Washington, D.C. during July and August, 1943, along the axis of an earlier considered dam 35 feet to 230 feet upstream of the present site.

CORPS OF ENGINEERS

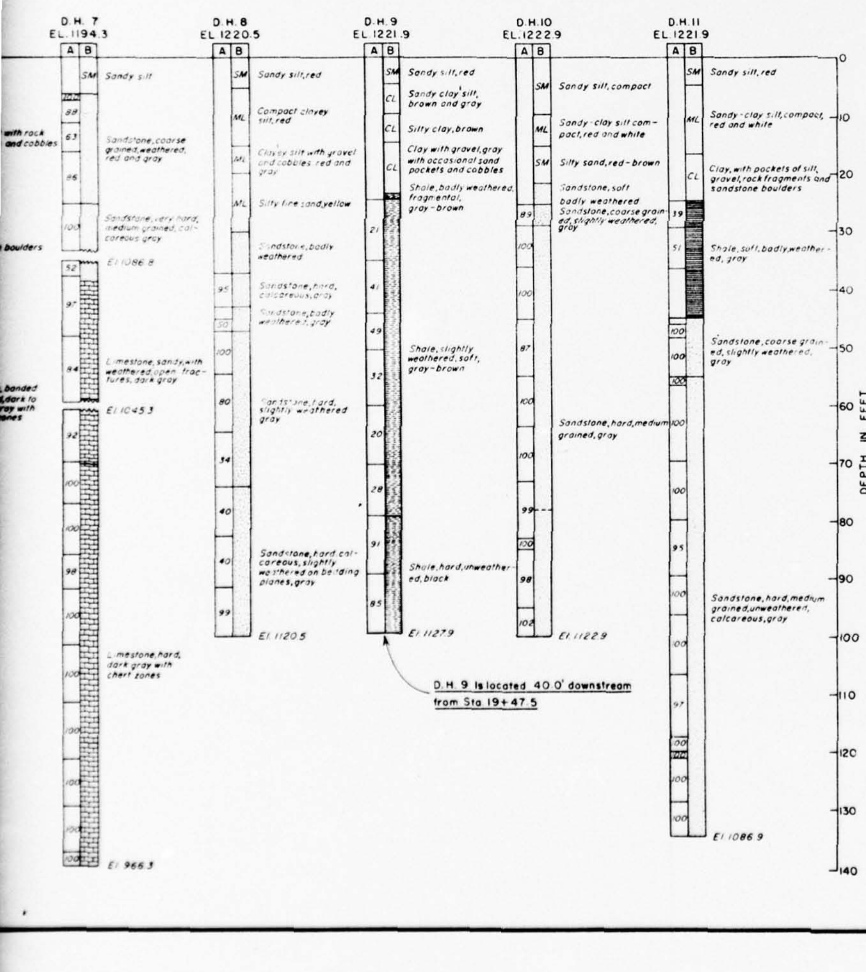


2

U. S. ARMY



PROFILE ON AXIS OF DAM
LOOKING DOWNSTREAM



LEGEND

SANDSTONE SHALE LIMESTONE

BEDROCK ZONING "D" (See text for identification)

A PERCENT CORE RECOVERY
B ROCK OR SOIL CLASSIFICATION (EM 1110-1-1806 App 1)
WATER TABLE NOT OBSERVED

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

ROYAL GLEN PROJECT
SOUTH BRANCH POTOMAC RIVER, W. VA.

GEOLOGIC PROFILE

SCALE: AS SHOWN

Drawn by: MMH & MC
Checked by: LLJ
Approved:
Title:
Date:

EXHIBIT 3-15

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For their location, see plan, exhibit 3-3, and profiles, exhibit 3-15. Ten of the drill holes were pressure tested to determine the leakage conditions. In addition to damsite investigation, auger borings were made in potential borrow areas (see exhibit 3-16). A summary of soil investigations is shown on table 3-7. Laboratory reports and borrow area boring logs are part of the permanent records of the 1944 Potomac River study. All auger borings and laboratory testing were accomplished by Engineering Office, Syracuse District, during the period October 1943 through January 1944.

Seismic exploration was conducted along the damsite area to further determine the depth of bedrock along the axis of the dam.

Foundation Determinations

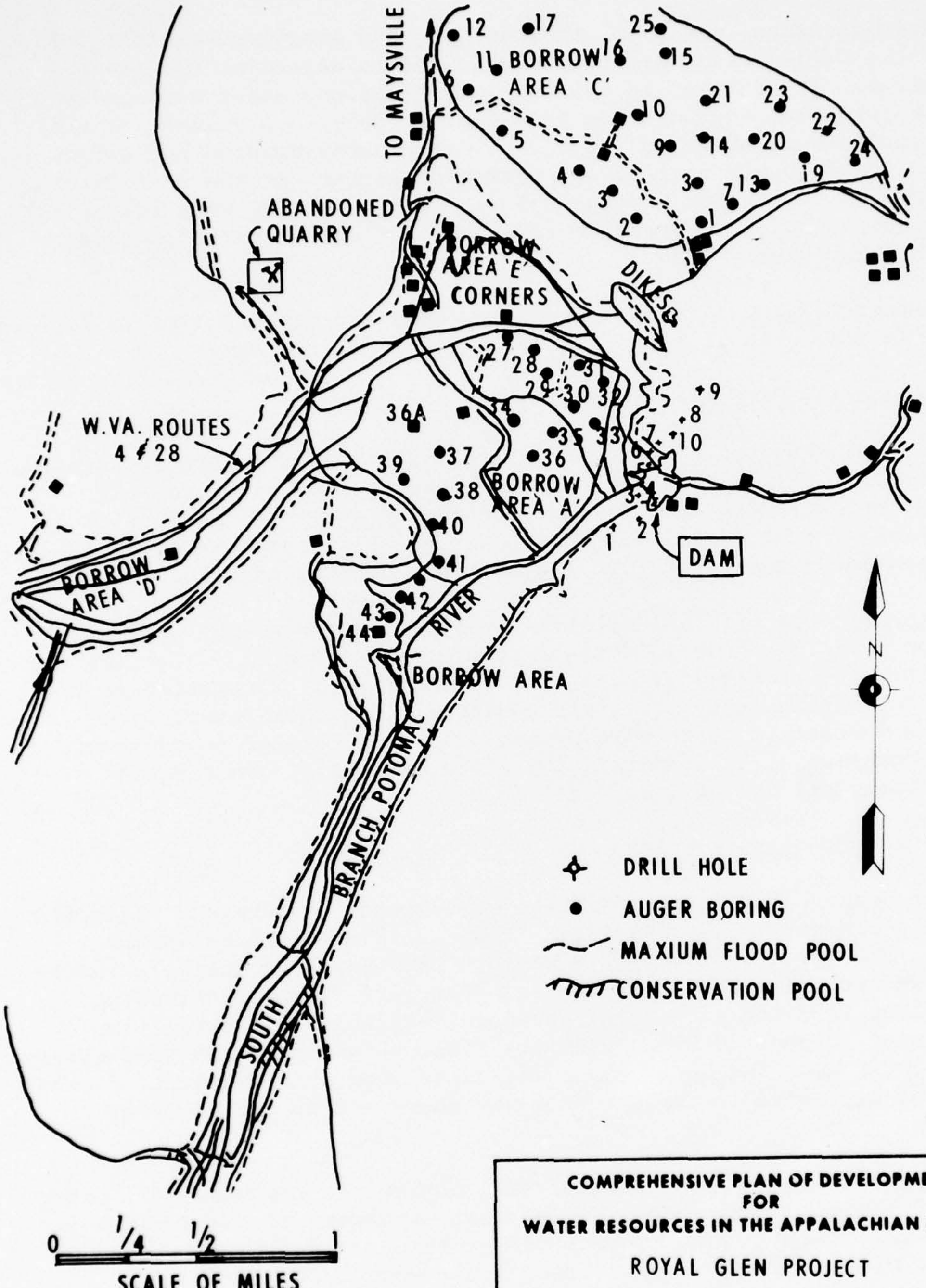
Suitable hard rock foundations are available at relatively shallow depths at the selected damsite for the construction of a concrete dam. No evidence was disclosed by the preliminary borings that an appreciable amount of solution has taken place in the Helderberg limestone. The approximate sound rock profile is shown on exhibit 3-15.

Although the original drilling program did not reveal extensive solution cavities, open joints, or other indications of a high leakage potential, the possibility does exist. Additional exploration in the abutments, particularly the right abutment ridge, may reveal open joints and fracture zones with caverns that are related to the fault zone downstream of the damsite; therefore, extensive grouting and dental treatment may be required.

Construction Materials

The Helderberg limestone is the best source of concrete aggregate materials present in the locality. Much of this formation is too cherty. However, there are thin members of massive, relatively chert-free limestone, favorably located for quarrying in the reservoir area, 1-1/2 miles from the site. Aggregate is available at the Williams Quarry near Romney, 30 miles from the site. Limestone from this quarry is currently used for base course for state road construction. Another source of aggregate is the Creer Quarry above and to the south of the site.

The most favorable sources of soil borrow are the residual, silty clays of the extensive Romney shale areas northwest of the damsite and the alluvial flood plain deposits of the broad valley immediately to the west of the damsite. Five hundred thousand cubic yards of impervious borrow is available within the reservoir with an additional one million cubic yards in an area adjacent to the downstream toe of the dike area. This downstream borrow area will satisfy the impervious soil requirements. Locations of borrow areas and of borings are shown on exhibit 3-16.



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

ROYAL GLEN PROJECT

PROSPECTIVE BORROW AREA

JANUARY 1968

Drawn by:________ Approved:________
Title:________
Checked by:________ Date:________

EXHIBIT 3-16

TABLE 3-7

SUMMARY OF SOIL INVESTIGATIONS - ROYAL GLEN PROJECT

Hole Number	Depth of Hole (ft.)	Depth (ft.)	Soil Class.*	Natural Water Cont. (%)	Opt. Moist. (%)	Unit Wt.@ Opt.Moist. lbs/cu.ft.	Coeff. of Perm. cm/sec.10^{-4}	Direct Shear T/S.F.	Angle of Internal Friction
AB 1	6.5	0 - 1.8	PT	20					
		1.8 - 6.5	SC						
AB 2	5.5	0 - 1.5	PT						
		1.5 - 5.5	SC						
AB 3	2.3	0 - 0.4	PT						
		0.4 - 2.3	Weathered Shale						
AB 4	3.5	0 - 1.4	PT						
		1.4 - 3.5	WS						
AB 5	2.5	0 - 1.2	PT						
		1.2 - 2.5	WS						
AB 6	4.6	0 - 3.0	PT						
		3.0 - 4.6	WS						
AB 7	9.3	0 - 1.8	PT		15.7	112.1	.00005-.00003	.31	25°20'
		1.8 - 5.3	WS	15.4					
		5.3 - 9.3	CM	16.1					
AB 8	5.7	0 - 2.8	PT	17.0					
		2.8 - 5.7	WS						
AB 9	4.5	0 - 1.0	PT	8.8					
		1.0 - 4.5	WS						
AB 10	7.8	0 - 2.2	PT	31.2	19.0	107.5	.00005-.00003	.33	22°30
		2.2 - 6.2	CH						
		6.2 - 7.8	WS						
AB 11	6.5	0 - 6.5	WS	15	19.0	107.5	.00005-.00003	.33	22°30'
AB 12	1.2	0 - 1.2	WS						
AB 13	5.7	0 - 3.5	PT		15.7	112.1	.00005-.00003	.31	25°20'
		3.5 - 5.7	WS						
AB 14	9.8	0 - 2.0	PT	14.2	15.7	112.1	.00005-.00003	.31	25°20'
AB 15	8.5	0 - 1.0	PT						
		1.0 - 8.5	CL	27.7	23.0	101.8	.00004-.00002	.28	20°10'
AB 16	4.6	0 - 0.9	PT	20.4	19.0	107.5	.00005-.00003	.33	22°30'
		0.9 - 4.6	CL						
AB 17	1.7	0 - 1.7	WS						
AB 18	1.0	0 - 1.0	WS						
AB 19	10.8	0 - 1.5	WS	14.8	15.7	112.1	.00005-.00003	.31	25°20'
		1.5 - 10.8	CL						
AB 20	6.1	0 - 1.0	PT						
		1.0 - 4.8	CL	29.6					
		4.8 - 6.1	WS	16.8					
AB 21	4.7	0 - 3.3	PT		23.0	101.8	.00004-.00003	.28	20°10'
		3.3 - 4.7	CL	12.2					
AB 22	6.0	0 - 1.5	PT						
		1.5 - 3.8	CL	23.2					
		3.8 - 6.0	WS	9.9					
AB 23	8.0	0 - 1.0	PT		23.0	101.8	.00004-.00003	.28	20°10'
		1.0 - 6.3	CL-MH	21.6					
		6.3 - 8.0	WS	11.6					
AB 24	3.6	0 - 2.7	PT						
		2.7 - 3.6	WS						
AB 25	9.5	0 - 2.3	PT						
		2.3 - 3.5	CL	30.6					
		5.0 - 9.5	CL-WS	21.0					

TABLE 3-7 (CONT'D)

SUMMARY OF SOIL INVESTIGATIONS - ROYAL GLEN PROJECT

Hole Number	Depth of Hole (ft.)	Depth (ft.)	Soil Class.*	Natural Water Cont. (%)	Opt. Moist. (%)	Unit Wt.@ Opt.Moist. lb/cu/ft.	Coeff.of Perm. cm/sec.10^{-4}	Direct Shear	Angle of Internal Friction
AB 26	7.7	0 - 1.5	PT		19.0	107.5	.00005-.00003	.33	22°30'
		1.5 - 4.6	CL	9.6					
		4.6 - 7.7	SM	24.4					
AB 27	8.2	0 - 6.1	PT		13.5	118.4	.00009	.11	32°40'
		6.1 - 8.2	GM						
AB 28	11.6	0 - 4.0	PT		13.5	118.4	.00009	.11	32°40'
		4.0 - 11.6	CL	17.6					
AB 29	7.3	0 - 5.2	PT		13.5	118.4	.00009	.11	32°40'
		5.2 - 7.3	GW						
AB 30	7.6	0 - 2.2	PT						
		2.2 - 7.6	GW						
AB 31	11.7	0 - 7.0	PT		13.5	118.4	.00009	.11	32°40'
		7.0 - 11.7	GW	15.9					
AB 32	8.3	0 - 1.0	PT						
		1.0 - 4.2	CL	13.2					
		4.2 - 8.3	GP						
AB 33	8.1	0 - 3.8	PT						
		3.8 - 8.1	GW						
AB 34	6.1	0 - 6.1	PT						
AB 35	4.2	0 - 4.2	PT						
AB 36	4.8	0 - 4.8	PT						
AB 36A	2.0	0 - 2.0	PT-GP						
AB 37	7.0	0 - 2.0	PT						
		2.0 - 4.2	CL						
		4.2 - 2.7	GW						
AB 38	5.8	0 - 4.0	PT						
		4.0 - 5.8	GW						
AB 39	2.0	0 - 2.0	Sandstone Boulders						
AB 40	4.2	0 - 2.9	PT						
		2.9 - 4.2	GW						
AB 41	8.2	0 - 5.1	PT						
		5.1 - 8.2	GW						
AB 42	16.5	0 - 9.5	WS	15.9	20	105.0	-	.24	23°30'
		9.5 - 16.5	CH	16.1					
AB 43	21.0	0 - 3.8	WS	19.3	15	116.2	-	.27	27°50'
		3.8 - 21.0	WS-CL						
AB 44	13.5	0 - 3.8	CL	20.6	20	105.0		.24	23°30'
		3.8 - 8.5	CL-WS	17.1					
		8.5 - 13.5	CL	22.9					

* EM 1110-1-1806, App. 1, visual classification.

Mineral Resources Affected

The Bureau of Mines surveyed the Royal Glen Project area to determine the project's effect on mineral production and resources. BOM's report on the site is contained in Appendix I of this Report. Only one active mineral producer, Bean's Lime and Stone Company, would be affected by the project. However, the proposed reservoir, with the top of conservation pool at elevation 1060 msl, would affect quarry operations very infrequently, as the reservoir would reach elevation 1100, the lowermost level of the quarry floor, only about once in 50 years.

BOM stated that the undeveloped limestone reserves would largely be considered unattractive for production due to lack of accessibility and markets. BOM also stated that the appropriate action, protection or relocation of Bean's quarry, would require further study, although some compensation was considered necessary.

The entrance to the Smoke Hole Caverns would be protected by a wall designed to prevent intrusion of reservoir waters during an exceptionally large flood without interfering with access to the caverns. This protection is included as an item of project cost. The elevation of the entrance to the caverns is about elevation 1117 which is the maximum flood pool elevation and has probability of occurring once in 100 years.

Conclusions

No geologic conditions were disclosed by the investigations that would preclude or greatly complicate the construction of the proposed dam at Royal Glen. Cost analyses indicate that a concrete gravity-type structure is more economical than a rock-and-earth fill type. Studies at the design level should be made which thoroughly investigate the geological conditions of the right abutment and the dike area.

12. STRUCTURAL

The proposed dam would be a concrete gravity-type structure 643 feet long, with a maximum height of 148 feet above the streambed, and a gated spillway section near the existing river channel. The top of the dam would be 20 feet wide and would be traversed by the access road to the operations tower.

The spillway would have a net length of 126 feet and discharges through the structure would be controlled by three 42- by 47-foot tainter gates. The spillway crest would be at elevation 1070, ten feet above the top of the conservation pool. Two 7- by 12-foot sluices located under the gate piers would be utilized for diversion of streamflow during construction and for operational releases from the flood control pool. The inverts of these conduits would be at elevation 985, only three feet above the streambed. The stilling basin would be 162 feet long and would dissipate the energy of discharges through the sluices and/or spillway by means of baffles and end sill.

A low-flow sluice would be provided with multilevel intakes discharging into a wet well for selectivity of releases for downstream fishery enhancement. This sluice would be placed in the non-overflow left abutment section and would discharge into the stilling basin via an orifice in the stilling basin wall.

The possibility of leakage which would require foundation grouting was previously discussed in paragraph 12.

An earthen dike would be required to prevent flows through a saddle located about 3,600 feet north of the dam. The dike would be 940 feet long and its maximum height would be 25 feet. A cutoff trench about 40 feet deep and extending to firm rock would eliminate underseepage.

13. RELOCATIONS

All highways and access roads which would be inundated by the reservoir would be relocated so as to maintain adequate transportation in affected areas. West Virginia State Route 4 would be relocated around the reservoir by construction of 6.5 miles of new highway, as shown on exhibit 3-4. One highway bridge over the reservoir and one-half mile of roadway would be constructed to maintain access to the Monongahela National Forest. Coordination must be maintained with the planning of Appalachian Corridor H, proposed in the vicinity of the reservoir to avoid possible conflicts in planning concepts. This coordination should be accomplished during the planning stages of the reservoir and Corridor H, with the State of West Virginia, the Forest Service (USDA) and the Corps of Engineers. In the vicinity of the proposed reservoir, Corridor H should be planned to follow generally the proposed location of the relocated 6.5 miles of West Virginia State Route 4 in order to be compatible with the reservoir plan. No railroads are affected by the project. Gas, electric, telephone, and water services would be relocated as necessary to provide the same level of services to properties not acquired that existed prior to project construction. There are only six known graves in the reservoir area which would require relocation.

14. REAL ESTATE

In order to construct and operate the dam and reservoir, it would be necessary to purchase in fee all land required for reservoir operation and public access, the working area surrounding the dam, and rights-of-way for relocated highways. The wildlife habitat lost in the affected area would be replaced by land purchased away from the project area for intensive wildlife management. This acquisition, and the purchase of additional land to provide for recreational facilities, would be at project expense. The estimated real estate requirements under 1967 conditions are summarized in table 3-8.

TABLE 3-8
REAL ESTATE REQUIREMENTS
ROYAL GLEN PROJECT

Reservoir operation and construction		
Open land, acres		1,580
Woodland, acres		760
Miscellaneous land, acres		140
Existing streams, acres		70
Major Buildings	133	
Cabins	90	
Dam and working areas, acres		50
Rights-of-way for relocations, acres		300
SUBTOTAL		2,900
Additional land for recreation, acres		740
Replacement of wildlife habitat, acres		700
TOTAL		4,340

15. RECREATION - THE CONCEPT EVOLUTION

The terrain surrounding the damsite is rugged with mountains rising to elevations of 3000 to 4000 feet above sea level. Some areas, especially on the north and the northeast side of the reservoir site have moderate slopes; however, the steep slopes of the remaining areas are generally above 15 percent. The site is located within the boundary of the Monongahela National Forest and the Spruce Knob-Seneca Rocks National Recreation area. Most of the lands now owned by the federal government and administered by the Forest Service are confined to the upper reaches of the rivers outside the reservoir area and through the mountain ridges. The reservoir site is immediately downstream from the area known as the Smoke Hole Canyon, a picturesque valley bordered by rugged mountains, which has outstanding natural and scenic qualities.

The area surrounding the project is highly scenic. The hillsides are covered with mixed hardwoods and pines except for occasional remote parings and rock outcroppings. The flood plain and the more moderate slopes, especially in the northeastern area, are used for agricultural purposes.

The South Branch Potomac River has been identified as having a high outdoor recreation potential as a free flowing stream. On the other hand, a shortage of slack water for recreational purposes exists in the National Recreation area. The impounded water area within 40 miles of the damsite consists primarily of small lakes of less than 25 acres, with a total area of about 150 acres suitable for water-oriented

recreation activities. There are available about 2,900 miles of streams suitable for canoeing and similar boating activities in the upper Potomac River Basin, and about 560,000 acres of land suitable for outdoor recreation activities, mostly in the Monongahela and George Washington National Forests, and Blackwater Falls and Lost River State Parks in West Virginia. Additional still-water would be provided by proposed and/or authorized water resource projects such as the 1,000-acre Bloomington Reservoir and the impoundments of USDA's upstream watershed projects in the Upper Potomac River Basin. Thus, the extremely high natural scenic values of the area and the potential conflict between different classes of recreational users dominate the formulation of and design of the recreational plan for the Royal Glen project. As discussed in previous paragraphs especially in the plan formulation section, a stable recreation pool combined with restrictions on the maximum elevation of flood waters and in the regulation of the project for flood control purposes characterize the design of this project.

Recreationists would have access to the reservoir via State Highways No. 42, 4, and 28, and U.S. Highway No. 220.

Water at this site is of satisfactory quality for outdoor recreation use. Franklin, West Virginia, upstream on the South Branch Potomac River, had been a significant source of waste until installation of a treatment facility.

Three day-use areas, shown on exhibit 3-1, would be developed. One would be along the north shore west of the proposed dike. A second would be along the west shore of the North Fork area of the reservoir, and the third at the north end of the peninsula between the two arms of the reservoir. Development would consist of picnic and beach areas, and boating and fishing access areas. A small marina would be developed along the north shore in the vicinity of "Corners."

Three overnight-use areas would be developed for tent and trailer camping. They would be located adjacent to the day-use area along the North Fork Section of the reservoir, on the south side of the North Fork in the vicinity of Hopeville Gap, and on the peninsula between the two arms of the reservoir. Primitive-type group campgrounds would also be developed in the vicinity of the reservoir.

The existing downstream fishery would be enhanced by the streamflow regulation and temperature selectivity of the reservoir, and by provision of access (including parking facilities) to the tail water area.

A vista point would be provided overlooking the reservoir with the location dependent upon further site analysis and the alignment of the proposed Appalachian Corridor. Interpretive signs and displays would be provided at the vista point and at other appropriate locations.

An exhibit building would be constructed for the display of natural, historical, and archeological resources of the area. Other development would include access and service roads, hiking trails, administration and service facilities, as well as the necessary health and safety features.

The channel improvement at Petersburg would extend approximately 12,800 feet. Although the clearing and excavating operations will probably alter the riffle-pool relation of the existing channel, any adverse effect should be offset by augmented flows during rainless periods. Recreation activities in this reach would also be expected to diminish as a consequence of more intensive urban and industrial development and use of streamside areas.

The wildlife habitat lost in the effected area will be replaced by land purchased away from the project area for intensive wildlife management. The acquisition of 700 acres for mitigation purposes would be a project expense and should be administered as part of the Spruce-Knob-Seneca Rocks National Recreation Area.

Reservoir regulation schedules will be arranged to permit minimum pool fluctuations during the recreation season. The proposed plan of operation would augment flows to 100 cfs year around and permit minimum releases of 360 cfs during April and May to enhance trout fishing in the tail water area of the project.

Estimated use of the reservoir and associated lands (by the Bureau of Outdoor Recreation-Appendix F) for general recreation purposes is 200,000 visitor days initially, increasing to an ultimate level of 480,000 visitors annually. The Fish and Wildlife Service estimated an average annual use of 23,200 fisherman days in the reservoir area and 7,100 fisherman days annually in the tail water area.

The anticipated dayload (the number of people using the area on an average weekend day during the peak month of use of the design year) is 9600 visitor days initially and 19,200 visitor days ultimately. Adjustment for the turnover in use of facilities would reduce the dayload to the design load of 4800 persons initially and 9600 persons ultimately. The design load was allocated between the following uses: picnicking, fishing, swimming, boating, camping, hiking, sightseeing, and miscellaneous according to the anticipated use of each kind of facility. A detailed estimate of the costs associated with general recreation facilities and fish and wildlife enhancement and for the mitigation measures can be found in table 3-9.

No archaeological, historic, and natural science resources of value are known to exist in this area on which salvage and/or preservation may be necessary.

More detailed site plannings should await improved mapping of the area which would be undertaken as part of the advanced engineering and design studies following authorization.

TABLE 3-9
DETAILED SUMMARY OF RECREATION FACILITY COSTS
ROYAL GLEN PROJECT, W. VA.

Item	Unit	Unit Cost	Initial Quantity	Initial Amount	Future Quantity	Future Amount	Total Quantity	Total Amount
Picnicking	Each	$400	72	$29,000	72	$29,000	144	$58,000
Picnic Shelters	Each	5,000	5	25,000	5	25,000	10	50,000
Swimming	Sq.Ft.	.25	108,000	27,000	108,000	27,000	216,000	54,000
Bath House	Each	15,000	3	45,000	3	45,000	6	90,000
Boating	Each	18,000	5	90,000	5	90,000	10	180,000
Parking	Each	200	960	192,000	960	192,000	1,920	384,000
Sanitation	Each	7,500	15	113,000	15	113,000	30	226,000
Water System	Each	1,000	96	96,000	32	32,000	128	128,000
Camping	Each	1,500	192	288,000	192	288,000	384	576,000
Roads	Mile	60,000	5	300,000	2.5	50,000	7.5	350,000
Administration	Each	100,000	.7	70,000	.3	30,000	1	100,000
Group Camp	Each	125,000	.5	62,500	.5	62,500	1	125,000
Trails	Mile	16,000	.5	8,000	.5	8,000	1	16,000
Signs	Design Load	.25	.5	1,000	.5	1,000	1	2,000
Obs./Sightseeing	Each	6,000	1.5	9,000	.5	3,000	2	12,000
Landscaping	Design Load	1.50	.5	6,000	.5	6,000	1	12,000
TOTAL (Jan 63)				1,361,500		1,001,500		2,363,000
Updated (Jul 67)				1,724,000		1,268,000		2,992,000
Contingencies				256,000		192,000		448,000
TOTAL				1,980,000		1,460,000		3,440,000

SECTION IV - COST ESTIMATES

16. PROJECT COSTS

Capital costs were derived by applying unit prices to survey scope design and quantity estimates. These unit prices reflect July 1967 price levels and were developed from Corps of Engineers experience with similar projects in the Baltimore District. Contingency allowances of 15 to 25 percent were added to each cost account to compensate for the depth of the study.

The costs for lands and damages were based on real estate values prevailing in the project area. These values were derived through studies of recent real estate transactions and sales contracts in the local area.

The costs of recreation facilities were derived by estimating the facilities required to handle the expected visitation. The method of discounting future expenditures for recreation facilities was set forth in technical papers by the Office of Appalachian Studies.

Annual costs were computed at an interest rate of 3.25 percent over an economic analysis period of 100 years. Operation and maintenance costs were estimated from appropriate labor and materials prices. Costs for the replacement of major items were calculated using predicted replacement times.

Cost summaries and detailed cost estimates for the project are shown in tables 3-10, 3-11, 3-12, and 3-13.

TABLE 3-10
SUMMARY OF CAPITAL COST
ROYAL GLEN PROJECT
(July 1967 Prices)

No.	Item	Cost	Costs With Indirect Costs Distributed
1.	Lands and Damages		
	(a) Joint Use	$2,570,000	$2,570,000
	(b) Recreation	150,000	150,000
2.	Relocations	2,640,000	3,065,000
3.	Reservoir	310,000	360,000
4.	Dam and Appurtenances	14,480,000	16,830,000
5.	Fish and Wildlife Mitigation Lands	70,000	70,000
6.	General Recreational Facilities		
	(a) Initial Development	1,980,000	2,130,000
	(b) Future Development	1,460,000	1,570,000
7.	Flood Protection	10,000	12,000
8.	Channel Improvement	1,150,000	1,338,000
9.	Beautification	540,000	540,000
10.	Permanent Operating Equipment	90,000	105,000
11.	Buildings, Grounds, and Utilities	290,000	340,000
12.	Engineering and Design		
	(a) Initial Development	2,210,000	-
	(b) Future Development	90,000	-
13.	Supervision and Administration		
	(a) Initial Development	1,020,000	-
	(b) Future Development	20,000	-
14.	TOTAL PROJECT COST		
	(a) Initial Development	27,510,000	27,510,000
	(b) Future Development	1,570,000	1,570,000
	(c) Total Development	29,080,000	29,080,000

TABLE 3-11
SUMMARY OF ANNUAL FINANCIAL COST ($1,000)
ROYAL GLEN PROJECT

No.	Item	Cost
1.	Interest on Gross Investment	$964
2.	Amortization of Gross Investment	41
3.	Maintenance and Operation	78
4.	Major Replacements	39
5.	Future Increment of Recreation	62
	TOTAL	$1,184

TABLE 3-12
DETAILED ESTIMATE OF CAPITAL COSTS
ROYAL GLEN PROJECT
(July 1967 Price Level)

No.	Item	Unit	Quantity	Unit Price	Amount
1.	LANDS AND DAMAGES				
	A. RESERVOIR				
	Surface acquisition				
	Agricultural Land	Acre	1,594	$100	$ 159,400
	Wooded Land	Acre	759	60	45,500
	Residential	Acre	177	750	132,800
	Dam, Dike, Other Work Areas	Acre	50	80	4,000
	Subtotal		2,580		$ 341,700
	Buildings	Set	214	-	$1,418,300
	Severence Damage	L.S.	-	-	60,000
	Subtotal, Surface Lands and Damages				$1,820,000
	Contingencies				430,000
	TOTAL				$2,250,000
	Summary				
	Surface Acquisition				$2,250,000
	Resettlement				63,000
	Acquisition Cost				257,000
	TOTAL, LANDS AND DAMAGES, RESERVOIR				$2,570,000
	B. RECREATION	L.S.			150,000
	TOTAL, LANDS AND DAMAGES				$2,720,000
2.	RELOCATIONS				
	Highways				
	State	Mile	6.5	-	$1,950,000
	County	Mile	1.0	-	250,000
	Subtotal				$2,200,000
	Cemeteries				
	Graves	Each	6	$250	1,500
	Subtotal				$2,201,500
	Contingencies				438,500
	TOTAL, RELOCATIONS				$2,640,000

TABLE 3-12 (Cont'd)

No.	Item	Unit	Quantity	Unit Price	Amount
3.	RESERVOIR				
	Clearing Wooded Land	Acre	615	$350	$ 215,200
	Clearing Buildings	L.S.			44,800
	Subtotal				$ 260,000
	Contingencies				50,000
	TOTAL RESERVOIR				$ 310,000
4.	DAM AND APPURTENANCES				
	Non-Overflow Section				
	Care and Diversion of Water	L.S.	1	-	$ 221,500
	Clearing & Grubbing				
	Construction Area	Acre	30	$500.00	15,000
	Borrow Area	Acre	21	450.00	9,000
	Excavation				
	Unclassified	C.Y.	155,400	1.20	186,500
	Weathered Rock	C.Y.	26,000	2.50	65,000
	Solid Rock	C.Y.	16,800	3.50	58,500
	Excavation Borrow				
	Impervious	C.Y.	213,400	1.20	256,100
	Pervious	C.Y.	16,700	2.00	33,400
	Embankment, place				
	Impervious	C.Y.	213,400	0.35	74,700
	Pervious	C.Y.	16,700	0.50	8,400
	Bedding Material	C.Y.	1,000	7.00	7,000
	Top Soil	L.S.	1	-	100
	Riprap Dumped	C.Y.	2,800	18.00	50,400
	Foundation Preparation				
	Earth	S.Y.	8,900	2.50	22,300
	Concrete	S.Y.	6,400	3.50	22,400
	Concrete				
	Mass	C.Y.	181,000	23.00	4,163,000
	Cement	Bbl.	181,000	6.00	1,086,000
	Reinforcing Steel	Lb.	54,300	0.18	9,800
	Back Fill Compacted	C.Y.	16,300	3.00	48,900
	Stripping	C.Y.	18,700	1.10	20,600
	Drilling Grout Holes	L.F.	12,700	6.00	76,200
	Pressure Grouting	C.F.	28,700	4.00	114,800
	Selected Rock	C.Y.	34,800	6.00	208,800
	Water Stops, Rubber	L.F.	2,000	3.50	7,000

TABLE 3-12 (Cont'd)

No.	Item	Unit	Quantity	Unit Price	Amount
	Non-Overflow Section (cont'd)				
	Seeding	Acre	1	$600.00	$ 600
	Slope Drainage System	L.S.	1	-	32,000
	Stairways and Handrails	Lb.	41,700	0.65	27,100
	Miscellaneous Metal	Lb.	81,000	0.80	64,800
	Dental Treatment	L.S.	1	-	54,600
	Subtotal				$6,944,800
	Contingencies				1,385,200
	TOTAL NON-OVERFLOW SECTION				$8,330,000
	Overflow Section				
	Clearing & Grubbing Construction Area	Acre	7	$500.00	3,500
	Excavation				
	Unclassified	C.Y.	6,100	1.20	7,300
	Solid Rock	C.Y.	11,600	3.50	40,600
	Sump Pumps	L.S.	1	-	20,000
	Foundation Preparation Concrete	S.Y.	5,500	3.50	19,300
	Concrete				
	Mass	C.Y.	56,600	23.00	1,301,800
	Walls	C.Y.	5,800	55.00	319,000
	Piers	C.Y.	5,300	65.00	344,500
	Slabe	C.Y.	3,400	40.00	136,000
	Cement	Bbl.	106,500	6.00	639,000
	Reinforcing Steel	Lb.	1,724,300	0.18	310,400
	Back Fill Compacted	C.Y.	3,000	3.00	9,000
	Stripping	C.Y.	6,400	1.10	7,000
	Drilling Grout Holes	L.F.	1,300	6.00	7,800
	Pressure Grouting	C.F.	2,800	4.00	11,200
	Crestgates, Tainter	Each	3	245,000.00	735,000
	Bridge, Spillway	S.F.	2,800	26.00	72,800
	Structural Steel	Lb.	113,500	0.55	62,400
	Pine, Steel with Fittings	Lb.	39,000	0.60	23,400
	Pipe, Cast Iron with Fittings	Lb.	21,000	0.55	11,600
	Pipe, Concrete Drain	L.S.	1	-	14,000

TABLE 3-12 (Cont'd)

No.	Item	Unit	Quantity	Unit Price	Amount
	Overflow Section (cont'd)				
	Dental Treatment	L.S.	1	-	$ 5,400
	Electrical System	L.S.	1	-	100,000
	Subtotal				$4,201,000
	Contingencies				849,000
	TOTAL, OVERFLOW SECTION				$5,050,000
	Outlet Works				
	Sluice Gates				
	Hydraulic	Each	4	$125,000.00	$ 500,000
	Low Flow Sluice				
	System	L.S.	1	-	70,000
	Elevator	L.S.	1	-	35,000
	Operations Tower	L.S.	1	-	65,000
	Electrical System	L.S.	1	-	20,000
	Subtotal, Outlet Works				$ 690,000
	Contingencies				140,000
	TOTAL, OUTLET WORKS				$ 830,000
	Access Road				
	Access Road	L.S.	1	-	$ 226,000
	Contingencies				44,000
	TOTAL, ACCESS ROAD				$ 270,000
	TOTAL DAM AND APPURTENANCES				$14,480,000
5.	FISH AND WILDLIFE MITIGATION LANDS	L.S.	1	-	$ 70,000
6.	RECREATION				
	Initial Development				
	Facilities Cost	L.S.	-	-	1,724,000
	Contingencies				256,000
	TOTAL, INITIAL DEVELOPMENT				$1,980,000
	Future Development				
	Facilities Cost	L.S.	-	-	$1,268,000
	Contingencies				192,000
	TOTAL, FUTURE DEVELOPMENT				$1,460,000
	TOTAL, RECREATION				$3,440,000

TABLE 3-12 (Cont'd)

No.	Item	Unit	Quantity	Unit Price	Amount
7.	FLOOD PROTECTION				
	Flood Protection for Smoke Hole Caverns	L.S.	-	-	$ 8,000
	Contingencies				2,000
	TOTAL, FLOOD PROTECTION				$ 10,000
8.	CHANNEL IMPROVEMENT				
	Channel Excavation	C.Y.	826,000	$1.20	$ 991,200
	Stripping	C.Y.	270	1.10	300
	Excavation	C.Y.	920	1.20	1,200
	Embankment	C.Y.	1,625	0.50	800
	Rip Rap dumped	C.Y.	75	18.00	1,400
	Contingencies				155,100
	TOTAL, CHANNEL IMPROVEMENT				$1,150,000
9.	BEAUTIFICATION	L.S.	-	-	$ 540,000
10.	PERMANENT OPERATING EQUIPMENT				
	Standby Generator	L.S.	-	-	$ 20,000
	Radio	L.S.	-	-	15,000
	Stream Gage	L.S.	-	-	6,000
	Electrical Systems	L.S.	-	-	15,000
	Recording Gages	L.S.	-	-	10,000
	Communication System	L.S.	-	-	8,000
	Subtotal				$ 74,000
	Contingencies				16,000
	TOTAL, PERMANENT OPERATING EQUIPMENT				$ 90,000
11.	BUILDINGS, GROUNDS, AND UTILITIES				
	Utility System	L.S.	-	-	$ 60,000
	Operator's Quarters	L.S.	-	-	150,000
	Area Drainage System	L.S.	-	-	32,000
	Subtotal				$ 242,000
	Contingencies				48,000
	TOTAL, BUILDINGS, GROUNDS, AND UTILITIES				$ 290,000

TABLE 3-12 (Cont'd)

No.	Item	Unit	Quantity	Unit Price	Amount
12.	ENGINEERING AND DESIGN				
	Initial Development	L.S.	-	-	$2,210,000
	Future Development	L.S.	-	-	90,000
	TOTAL, ENGINEERING AND DESIGN				$2,300,000
13.	SUPERVISION AND ADMINISTRATION				
	Initial Development	L.S.	-	-	$1,020,000
	Future Development	L.S.	-	-	20,000
	TOTAL, SUPERVISION AND ADMINISTRATION				$1,040,000

TABLE 3-13
DETAILED ESTIMATE OF ANNUAL FINANCIAL COST
ROYAL GLEN PROJECT

ITEM	COST
TOTAL INITIAL INVESTMENT	
1. Total Construction Cost	$27,510,000
2. Interest During Construction	2,123,000
3. Total Gross Investment	$29,633,000
ANNUAL COSTS FOR INITIAL INVESTMENT	
1. Interest on Gross Investment	$ 964,000
2. Amortization	41,000
3. Maintenance and Operation	
(a) Dam and Reservoir	30,000
(b) Recreation	48,000
4. Major Replacements	
(a) Dam and Reservoir	20,000
(b) Recreation	19,000
5. TOTAL ANNUAL COST FOR INITIAL INVESTMENT	$ 1,122,000
6. ANNUAL COST OF FUTURE INVESTMENT	62,000
7. TOTAL ANNUAL COST FOR INITIAL AND FUTURE INVESTMENT	$ 1,184,000

17. DEVELOPMENT COSTS

The costs over and above the Royal Glen Project required to provide employment in the Industrial Park at Petersburg, W. Va. have been estimated by a short cut procedure since a detailed land use and investment plan has not been completed. A figure of $23,000 per employee has been adopted, and is comparable to the per employee cost estimated in the Upper Licking Survey Report. This figure has public sector costs built into it, representing over 50 percent of the total costs, and is considered to be applicable to the Royal Glen Project.

A total investment cost of $176,318,000 would be required to be put in place by 2020 for the 7,666 jobs estimated to be accommodated in the industrial park. The average annual equivalent value of charges, discounted at 3-1/4 percent and amortized at 5 percent would be $3,956,000. Since only a portion of the wage flows (see exhibit 3-20) were counted as benefits net to the nation and to the region, it could be argued that the costs should be adjusted in a similar manner. This adjustment would reduce the annual charges to approximately one-third of the above value. Yet, the total cost would be incurred to implement the plan and it could be argued that gross costs should be used. Annual costs of $3,956,000 are considered to be an adequate estimate for the purpose of the performance indices.

Investment costs of approximately $1,980,000 would be required to supply the goods and services demanded by recreational users of the project. The estimated annual value is $80,000. A summary of developmental cost is presented below:

TABLE 3-14
SUMMARY OF DEVELOPMENTAL COSTS ($1,000)
ROYAL GLEN PROJECT, WEST VIRGINIA

Item	Capital Cost	Average Annual Value
Development of Industrial Park at Petersburg	$176,318	$3,956
Recreation Investment	1,980	80
TOTAL	$178,298	$4,036

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SECTION V - BENEFITS

18. SUMMARY

The purposes for the Royal Glen Project are flood control, fishery enhancement, recreation and economic expansion. It will provide flood reduction at the downstream growth centers of Petersburg, Moorefield, and Rommey, West Virginia. The reservoir will also provide a recreation pool and associated recreation facilities. The recreation area will be located within the existing Spruce Knob-Seneca Rocks National Recreation Area of the Monongahela National Forest and will provide slackwater recreation within this area.

Expansion of Appalachian and National incomes will accrue from the employment generated by project construction and operation, from the expenditure by recreational users of the project and from the industrial expansion encouraged in Petersburg on flood plain lands rendered relatively flood-free.

A summary of benefits to users and from economic expansion by regional and national income attributes is presented below.

TABLE 3-15
SUMMARY OF BENEFITS
ROYAL GLEN PROJECT, WEST VIRGINIA

	ANNUAL BENEFITS ($1000)				
Category and Class of Benefits	National Account Only	Regional Account Only	National & Regional Account	Total National Account	Total Regional Account
User Benefits					
Flood Control		-	878	878	878
Recreation	166	-	415	581	415
TOTAL USER BENEFITS	166	-	1,293	1,459	1,293
Expansion Benefits					
Redevelopment	-	90	124	124	214
Development	-	3,076	4,151	4,151	7,227
Offset for loss in labor income	-	(62)	(36)	(36)	(128)
TOTAL EXPANSION BENEFITS	-	3,104	4,239	4,239	7,313

19. USER BENEFITS

User benefits have been estimated by various methods to approximate the value that the users would be willing to pay for the goods and services directly produced by this project.

Flood Control

Average annual flood control benefits were calculated in the conventional manner using stage-damage, stage-discharge, and discharge-frequency data. The damage survey for the flood plain to be protected by the Royal Glen Project was made in 1958 and 1959, and the data were updated based on a field investigation made in 1967. Stage-discharge and discharge-frequency data used for the preparation of the Potomac River Basin Report of 1963 were adjusted to reflect present flood plain development and then used for flood damage computations. Growth factors were computed to reflect the anticipated rate of growth in the flood plain. Rates of past growth and the physical features of the flood plain were used to determine the projected normal growth in the flood plain.

The average annual flood damages and benefits, by reaches, and by damage category for the Royal Glen Project are shown in table 3-16. The reach locations are shown on exhibit 3-17.

An additional category of flood control user benefits that can be expected with the project results from increased economic activity. Estimates of benefits with normal growth (residential, commercial, and industrial only) were adjusted to include increases in the added value of the properties and contents in the overflow area. Per capita personal income is projected to increase at a rate of 2.75 percent, compounded annually, in the growth centers. It was assumed that economic development within the flood plain will be slower than the projected growth in the area as a whole, and therefore, a rate of growth of 2 percent of the first 50 years and 1 percent for the second 50 years of the analysis period, compounded annually, was used to compute the economic increase adjustment.

The flood control user benefits resulting from the Royal Glen Project are shown in table 3-17 and a summary of flood control benefits is shown in table 3-18.

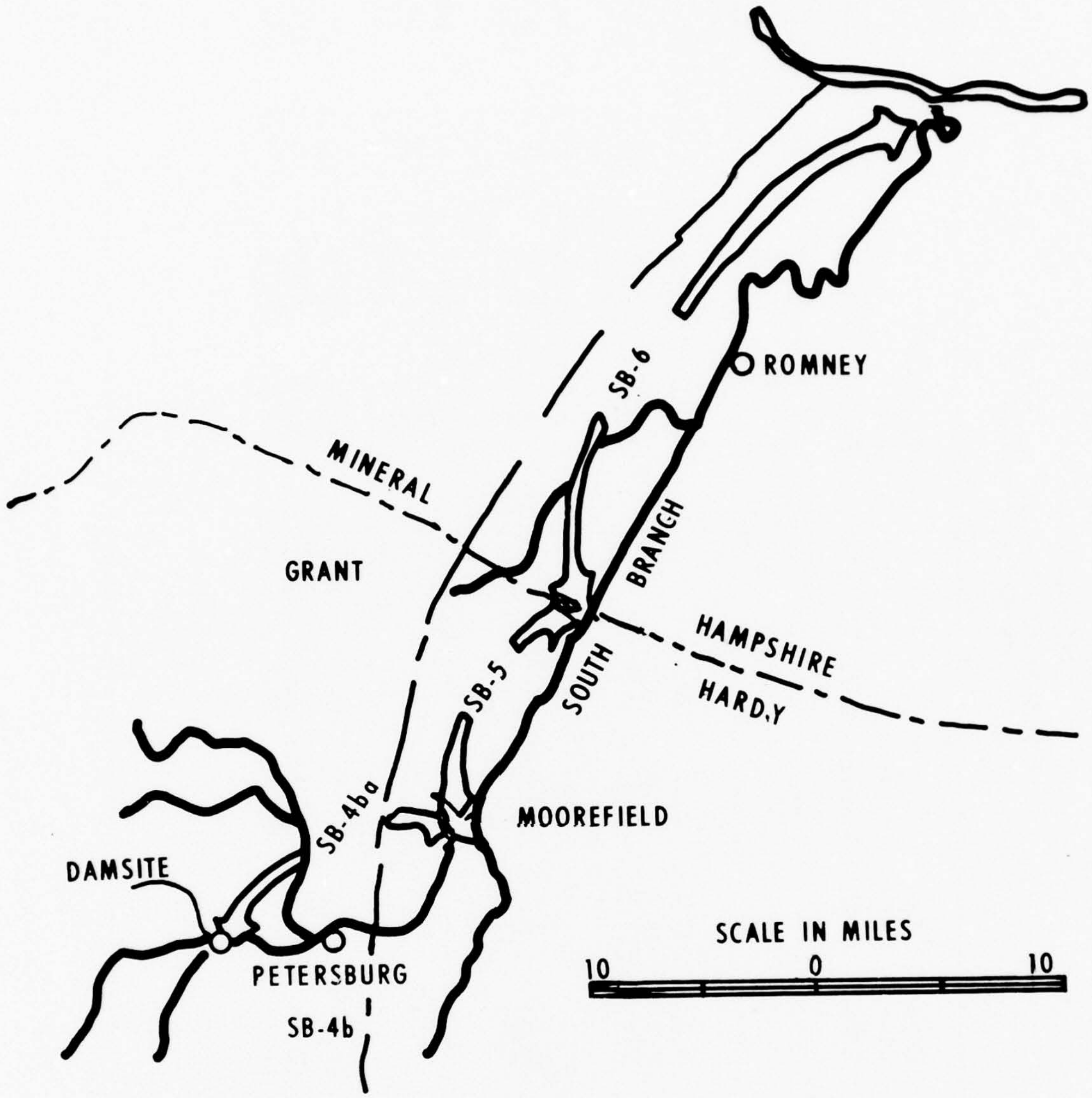
Enhancement benefits were computed for those areas which would be protected from the 100-year frequency flood, as defined with and without the reservoir. Approximately 1,200 acres of such land are located near the growth center of Petersburg.

The location of the potential industrial and commercial areas were determined from a review of preliminary drafts of the comprehensive development plans for Grant County and the Town of Petersburg, which identified proposed land use in the Petersburg area. These reports

TABLE 3-16
AVERAGE ANNUAL DAMAGES
ROYAL GLEN PROJECT
($1,000)

Reach	Condition	Residential	Commercial	Industrial	Public	Utilities	Transportation	Total Non-Agr.	Agriculture	Total
SB-4a	1/	-	-	-	-	2.0	22.7	24.7	48.4	73.1
	2/	-	-	-	-	0.3	3.7	4.0	9.6	13.6
	3/	-	-	-	-	1.7	19.0	20.7	38.8	59.5
SB-4b	1/	9.2	253.4	20.2	19.3	3.3	0.6	306.0	-	306.0
	2/	0.7	19.4	1.6	1.5	0.2	-	23.4	-	23.4
	3/	8.5	234.0	18.6	17.8	3.1	0.6	282.6		282.6
SB-5	1/	35.2	7.9	1.0	3.0	0.5	2.0	49.6	27.3	76.9
	2/	26.2	5.9	0.7	2.2	0.4	1.5	36.9	26.9	63.8
	3/	9.0	2.0	0.3	0.8	0.1	0.5	12.7	0.4	13.1
SB-6	1/	-	-	-	-	0.7	30.2	30.9	36.1	67.0
	2/	-	-	-	-	0.5	19.8	20.3	35.5	55.8
	3/					0.2	10.4	10.6	0.6	11.2
TOTAL	1/	44.4	261.3	21.2	22.3	6.5	55.5	411.2	111.8	523.0
	2/	26.9	25.3	2.3	3.7	1.4	25.0	84.6	72.0	156.6
	3/	17.5	236.0	18.9	18.6	5.1	30.5	326.6	39.8	366.4

1/ Without project.
2/ With project.
3/ Prevented by project.



FLOOD DAMAGE REACHES- ROYAL GLEN PROJECT

EXHIBIT 3-17

also emphasize the need for flood control in order to stimulate economic growth in the area. This land was identified as having good potential for attracting new industry into the town.

The estimated value per acre of the 1,200 acres for present use was based upon recent sales in the area. The total value before the project is estimated to be about $447,000. The projected worth of this land when used more intensively or for higher purposes, was estimated at $3,237,000. The increased value of land is predominantly a result of open land being upgraded for higher uses. This takes into consideration the proximity to urban centers, transportation facilities, utilities, and current development trends. The difference in the two values, or $2,790,000, was spread over the project life at a 5 percent interest rate to obtain an average annual enhancement benefit of $141,000. These benefits are all urban since agricultural activity near Petersburg is not expected to increase as a result of the flood protection.

TABLE 3-17
FLOOD CONTROL BENEFITS
ROYAL GLEN PROJECT
($1,000)

Reach	1967 Non-Agri. Development	Normal Growth	Projected Development	Economic Increase Adjustment	Agricultural Benefits 1/	Total
SB-4a	$ 20.7	$ 4.4	$ 25.1	$ 0.0	$38.8	$ 63.9
SB-4b	282.6	59.2	341.8	289.2	--	631.0
SB-5	12.7	2.7	15.4	12.6	0.4	28.4
SB-6	10.6	2.2	12.8	0.0	0.6	13.4
TOTAL	$326.6	$68.5	$395.1	$301.8	$39.8	$736.7

1/ Net agricultural benefits are expected to remain constant over the life of the project.

TABLE 3-18
SUMMARY OF AVERAGE ANNUAL FLOOD CONTROL BENEFITS
ROYAL GLEN PROJECT

Development, 1967	$366,400
Incremental Development	68,500
Subtotal	$434,900
Economic Increase Adjustment	301,800
Enhancement	141,000
Total Average Annual Benefits	$877,700
(Rounded)	$878,000

Recreation

General recreation benefits were based on the estimated net increase in number of persons expected to visit the project for recreational pursuits and the value of such visits. Visitation estimates were prepared by the Bureau of Outdoor Recreation and reviewed by the Baltimore District. These represent the number of persons who would visit the project for outdoor recreation pursuits during the economic analysis period. The value per visitor-day was based on Supplement 1 to Senate Document 97.

For a recreation pool at 1060 feet msl, the ultimate annual visitation would be 480,000 visitor-days. A value of $1.50 per visitor-day was used to compute the recreation benefits. This was determined by the quality of recreational facilities, and the reservoir relationship to the Monongahela National Forest and the Spruce Knob-Seneca Rocks National Recreation Area, and to the Petersburg service center. The growth of visitation curve that was adopted to compute the equivalent annual visitation and average annual benefits was provided in a letter from the Office of Appalachian Studies in August 1967, and is shown as exhibit 3-18. The average annual user benefits for general recreation are $553,300 (rounded to $553,000).

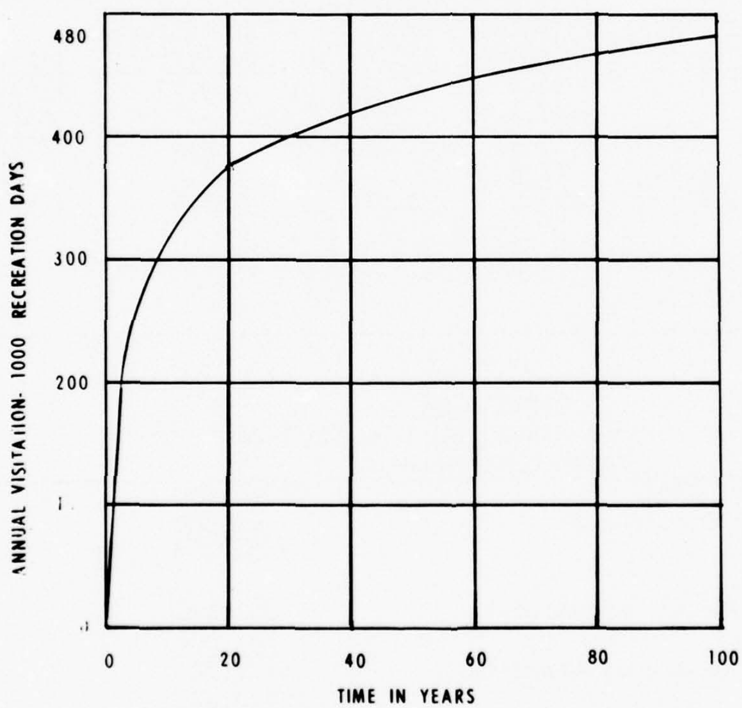


Exhibit 3-18 - Recreation Visitation Over Time.

Derivation of the net benefits to fishermen are given below in table 3-19. Gains are transferred to the benefit summaries while losses are carried as an economic cost of the project. Thus annual fishing benefits are estimated to be $28,000 (rounded) and losses are carried in costs of $7,800 annually. Hunting losses occasioned by construction and operation of the project (estimated at 270 man days) will be mitigated by provisions of 700 acres for intensive wild life management. A summary of user benefits is presented in table 3-20.

TABLE 3-19
FISHING BENEFITS
ROYAL GLEN PROJECT, W. VA.

Item	Trout	Small Mouth Bass	Pan Fish Large Mouth Bass
Losses (fisherman days)			
So. Branch Potomac (4.6 mi.)	1,400	2,400	
N. Fork Potomac (3.4 mi.)	4,300		
Downstream		35,600	
Total Losses	5,700	38,000	
Gains (fisherman days)			
Reservoir			23,200
Tailwater	500	36,000	
Tailwater Access	2,600	4,500	
Total Gains	3,100	40,500	23,200
Net Gains (fisherman days)	-2,600	2,500	23,200
Benefits (Per fisherman day)	$3.00	$2.00	$1.00
Net Benefits	-7,800	$5,000	$23,200

TABLE 3-20
SUMMARY OF USER BENEFITS
ROYAL GLEN RESERVOIR, W. VA.

Item	Amount ($1,000)
Flood Control	878
Recreation	581
TOTAL	1,459

20. EXPANSION BENEFITS

Expansion benefits are divided into two categories, redevelopment and developmental. Redevelopment benefits consist of wage payments made to persons employed in the construction, operation, and maintenance of the water resource project. Developmental benefits are measured in terms of wage payments made to persons not directly associated with this project, but whose employment results from the economic activity induced by this project.

Redevelopment Expansion Benefits

Initial contract construction costs of the Royal Glen Project would be $19,510,000. Construction of the initial recreation facilities would cost $1,980,000. The operation and maintenance labor costs for the dam would be $25,000 per year; for the ultimate recreation, $57,000 per year. The portion of these representing wages and salaries were determined using data from the Department of Labor. The work force was divided into those that would be hired locally and those that would be brought in from outside of the area. Although the unemployment rate in Grant County has declined over the past several years, it has not dropped proportionately with the national rate and is still well above the national average. In addition, the unemployment levels in Hampshire and Hardy Counties have been consistently above the national level. Therefore, a high proportion of locally hired workers was justified in calculating benefits.

Average annual figures were determined for the national and regional accounts. The national account represents the benefits from hiring unemployed persons in the region; the regional account accrues all the benefits, less the amount saved in unemployment compensation payments. The annual benefits accruing to the national and regional accounts are $123,700 and $213,500, respectively, as shown in table 3-21.

TABLE 3-21
SUMMARY OF REDEVELOPMENT BENEFITS
ROYAL GLEN PROJECT

Item	Expenditure	Labor Costs	Annual Redevelopment Benefits: National Account	Annual Redevelopment Benefits: Regional Account
Initial Construction				
Reservoir	$19,510,000	$5,657,900	$ 93,200	$174,300
Recreation	1,980,000	514,800	14,100	16,600
Annual Operation & Maintenance				
Reservoir	30,000	25,000	7,100	22,600
Recreation	96,000*	57,600*	9,300	38,600
Unemployment Payments				-38,600
TOTAL			$123,700	$213,500

* Ultimate

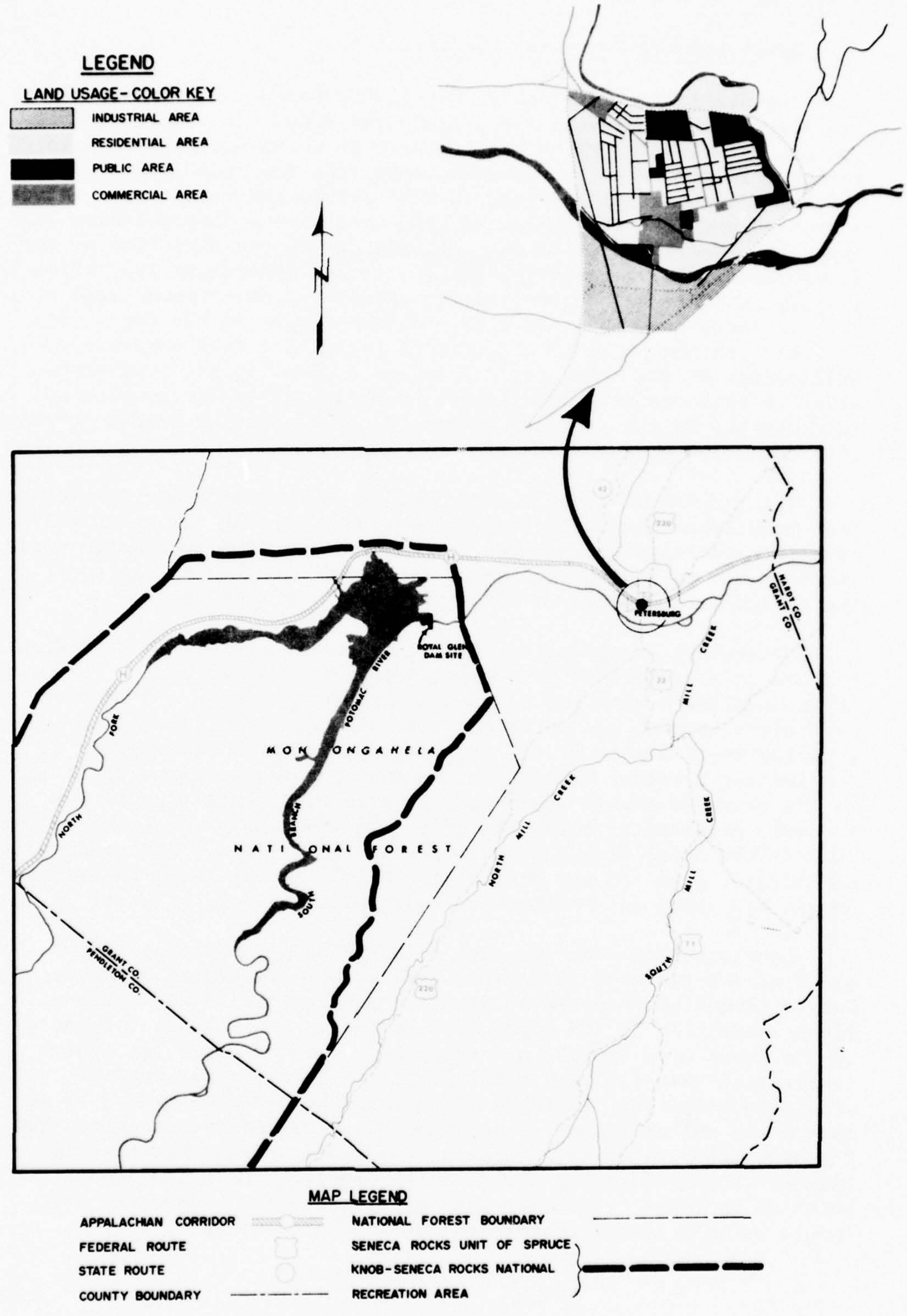
Developmental Expansion Benefits

The developmental plans of Petersburg include development of a 500 acre tract within the flood plain for industrial use. However, the natural flooding risks are too high to encourage investors to pursue this strategy. Development away from the flood plain would require a substantial addition to the highway and rail access network and would conflict with intended land uses in the comprehensive land use plan. Current development patterns are in the direction of the flood plain. The local development plan for Petersburg identifies this area as having a high potential for industrial development (see exhibit 3-19). Therefore, congruence of the development of the Royal Glen Project with the plans of the city of Petersburg with emphasis on utilization of the community's resource capability has been emphasized in this report. Development of the water resources plan and its relationship to the proposed industrial development has been coordinated with the mayor of Petersburg.

The industrial tract is the most readily foreseeable developmental impact on Petersburg and plans are far enough along for relatively sensitive estimates of changes in employment and incomes which could be attributable to implementation of the Royal Glen Project in addition to the Appalachian Corridor H which traverses the area.

Petersburg is one of the secondary growth centers in West Virginia and has been designated as a supplemental investment area. The designation implies a strategy to make investments which would make the area more attractive to new investment and provide urban services to surrounding rural areas as well as the growth center. Completion of Appalachian Corridor H will provide modern automotive and truck access to the area and should prove to be a significant stimulus to the economic development potential of the Petersburg growth center. Completion of the Royal Glen Project with implementation of the comprehensive development plan and aggressive growth policies by local interests should be phased to exploit the growth potential of the area.

Developmental benefits stem from the employment expected to occur on the 500 acre industrial park to be implemented by Petersburg citizens which would be provided a relatively high degree of flood protection by the Royal Glen Project. Other lands enchanced by the Royal Glen Project are expected to be developed for urban residential uses and have not been included in the estimate of expansion benefits. These benefits would be captured by use of an employment multiplier on direct manufacturing employment gains, but the benefits claimed for increased wholesale trade would also be included. Therefore, to avoid double counting, only the identified gains in wholsale trade have been added since the industrial park should be an attractive location for such activities.



PETERSBURG W. VA. LAND USE PLAN AND ROYAL GLEN PROJECT

EXHIBIT 3–19

Estimated increases of employment in manufacturing and wholesale trade are as follows:

	1980	2000	2020
Manufacturing	-	-	-
Gain over 1970	4,000	4,700	6,100
Income/Employment ($)	6,000	6,000	6,000
Gain in Income ($1,000)	24,000	28,200	36,600
Wholesale Trade			
Gain over 1970	180	650	1,566
Income/Employment ($)	5,000	5,000	5,000
Gain in income ($1,000)	900	3,250	6,830
Total Gain in Income ($1,000)	24,900	31,450	43,430

These values are shown graphically in exhibit 3-20 along with the adjustments utilized to estimate national and regional income gains.

Grant County, West Virginia has experienced prolonged and persistent unemployment. Unemployment rates for 1967 are estimated to be 6.3 percent down from 8.5 percent in 1960.*/ A cutoff reflecting a linear reduction of wage flows to zero by 1990 is considered to reasonably reflect national income gains attributable to successful implementation of the industrial aprk. Thus we assume full employment in the region by 1990. We have not used an employment multiplier in this estimate because of possible double counting of the wholesale trade component. National income gains are also net gains to the Appalachian Region.

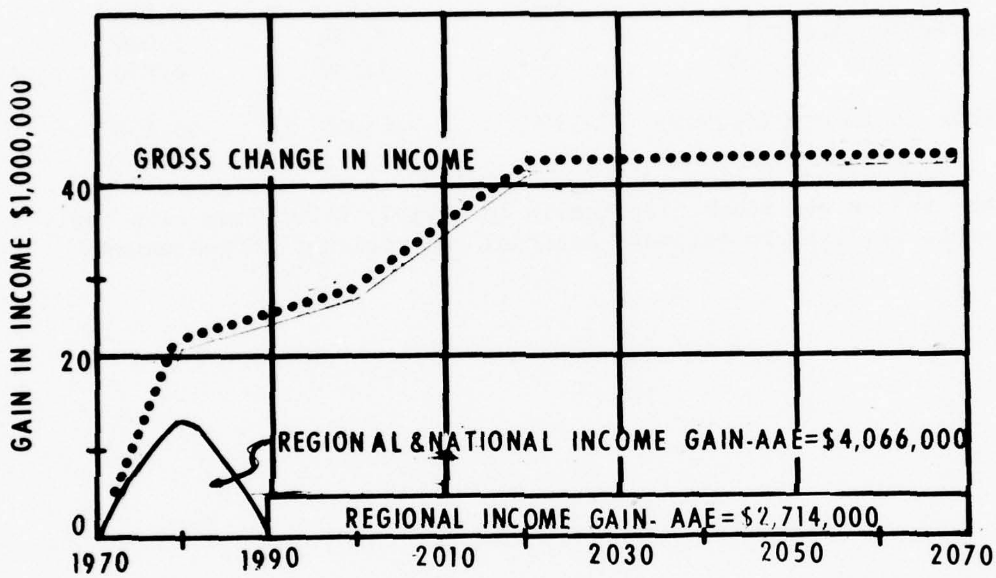


Exhibit 3-20. Estimated Gain in Income from Industrial Development at Petersburg, W. Va.

The Appalachian region will also receive an additional gain in income from the importation of skills from outside the region. An estimated 15 percent of total wage gain is expected to flow to these persons brought in from outside Appalachia.

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*/ SOURCE: Bureau of Employment Security Records, Martinsburg, West Virginia.

Average annual income gains, due to development of the industrial park at Petersburg, which would be encouraged by the flood control features of Royal Glen Project are estimated to be $4,066,000 net to the region and to the nation and an additional $2,714,000 net to the region only.

Expenditures by Recreational Users of the Royal Glen Project

The existence of the recreation complex at Royal Glen will have an economic effect on the region as a result of the expenditure made by the visitors to the recreation area. A portion of these expenditures will create new salaries and wages in the area and will expand the local economy.

For computing the developmental effect of reservoir recreation facilities, a generalized procedure that was adopted by the Office of Appalachian Studies was applied to the project. The developmental expansion benefits stemming from the recreational aspects of the reservoir will be realized in the communities located in the vicinity. They are measured as the amount of additional income and salaries paid to persons employed in the trades associated with recreation activities such as hotels, motels and transportation.

The Bureau of Outdoor Recreation furnished visitation estimates for each project and estimates the percentage of visitors traveling from each of four distance ranges to the site. The estimated daily expenditure per visitor for each of the distance ranges is shown in table 3-22.

TABLE 3-22
DAILY EXPENDITURE PER VISITOR FOR DISTANCE RANGES

ONE-WAY DISTANCE OF TRAVEL	DAILY EXPENDITURE PER VISITOR
0-25 miles	$0.50
26-50 miles	1.00
51-75 miles	2.00
more than 76 miles	4.00

The rate of annual visitation over the economic life of the project was assumed to follow the growth curve illustrated in exhibit 3-18. The visitation and expenditure data were used to calculate the expenditures of persons visiting the project recreation area.

The percentage of expenditures which represent wages to persons employed in industries associated with tourism was calculated by Robert R. Nathan Associates, in the Study entitled Recreation as an Industry. The study found that 37.7 percent of total expenditures will result in wages for persons in the area's recreation service occupations.

The data presented in table 3-23 and the 37.7 percent wage factor were applied to the visitation data supplied by the Bureau of Outdoor Recreation. A benefit function for expansion benefits was constructed to evaluate average annual expansion benefits associated with recreation activities attributable to the project.

The recreation expansion benefits for Royal Glen were calculated as a portion of the wages generated by general recreation and fishing visitation at the site. The Bureau of Outdoor Recreation furnished a distribution of visitation as shown in table 3-23.

TABLE 3-23
DISTRIBUTION OF VISITATION
ROYAL GLEN PROJECT, W. VA.

Distance of Visitor's Residence from Site (Miles)	% of Visitors Who Come This Distance at Maximum Development
0-25	40
26-50	10
51-75	20
over 75	30

The distribution of visitation over time was the same as that used for the calculation of user benefits. Based on the distance-expenditure/visitor distribution and the percentage of dollars spent that create wages, the annual wages resulting from ultimate annual visitation (503,100 visitor-days) are $360,371.

Before the average annual regional expansion benefits were calculated, a factor varying from one to zero over 100 years was applied to the benefit function, thereby decreasing the regional benefits in this period. This was done in anticipation that long run trends would improve the economic environment of Appalachia without the project. The average annual wages creditable to the regional account generated by visitation are $240,215. Using the county multiplier for Grant County, West Virginia (suggested in Recreation as an Industry by Robert R. Nathan Associates) of 1.86, the average annual regional account expansion benefits from recreation are $446,800.

Two additional modifications were necessary to evaluate the recreation expansion benefits accruing to the national account. The first was that the percentage of the benefits from wages that accrue to the national account decreases from 100 percent to zero over 20 years. The second modification was to evaluate what percentage of the wages will go to unemployed or underemployed persons. Table 3-24 shows how this percentage was evaluated.

TABLE 3-24
DISTRIBUTION OF SKILLS REQUIRED AND AVAILABLE-
ROYAL GLEN PROJECT, W. VA.

Category of Employment	% Required	% Supplied Locally	% of Total Supplied Locally
Management	10	0	0
Skilled	25	50	13
Semi-skilled	40	100	40
Unskilled	25	100	25
TOTAL	100		78

Therefore, 78 percent of the jobs will go to unemployed or underemployed persons. The average annual recreation expansion benefits to be credited to the national and regional account are estimated to be $85,000.

The above income gains should be reduced by the amount of employment in reservoir areas under current land use. An offset of $128,000 on the regional account and $36,000 on the national income account is utilized (representing an estimated 23 full-time jobs) to correct the estimate to a net basis.

A summary of the benefits for the Royal Glen Project is presented in table 3-25.

TABLE 3-25
SUMMARY OF EXPANSION BENEFITS ($1,000)
ROYAL GLEN PROJECT, W. VA.

Item	National	Regional
Redevelopment	124	214
Developmental		
Industrial Development		
Petersburg	4,066	6,780
Recreational Expenditures	85	447
Offset for loss of labor		
income on reservoir lands	(36)	(128)
TOTAL EXPANSION BENEFITS	4,239	7,313

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SECTION VI - ECONOMIC ANALYSES

21. ECONOMIC DATA

Project Costs

Annual charges were computed, utilizing data and developing cost estimates presented in Section IV of this Chapter. A summary of costs for the Royal Glen Project is shown in table 3-26.

TABLE 3-26
SUMMARY OF COSTS
ROYAL GLEN PROJECT AND ASSOCIATED INVESTMENT

Item	Amount ($1,000)
Construction Costs 1/	
Lands and Damages	2,790
Relocations	3,065
Reservoir	360
Dam and Appurtenances	16,830
Recreation 2/	3,700
Permanent Operating Equipment	105
Buildings, Grounds and Utilities	340
Flood Protection	12
Beautification	540
Channel Improvement	1,338
Total	29,080
Annual Charges	
Interest	964
Amortization	41
Maintenance and Operation	78
Major Replacements	39
Loss of land productivity and trout fishing	8
Future Increment of Recreation	62
Total	1,192
Construction Costs of Associated Investment	178,298
Annual Charges of Associated Investment	4,036
Total Annual Charges	5,228

1/ Includes cost of engineering, design, supervision and administration.
2/ Includes $1,570,000 for future recreation facilities.

Project Benefits

Annual economic benefits as developed as discussed in Section V are summarized in table 3-27 for the national and regional accounts.

Indices of Performance

One index of performance which is related to economic efficiency can be evaluated by reliance upon the conventional ratio of benefits to cost generally developed for water resources projects. The numerator contains annual user benefits plus those employment benefits contributable to direct construction and operation of water project (redevelopment benefits). The denominator is annual cost of water project.

TABLE 3-27
SUMMARY OF BENEFITS FOR PERFORMANCE INDICES
ROYAL GLEN PROJECT ($1,000)

Item	National	Regional
User	1,459	1,293
User and Redevelopment	1,583*	1,507
Expansion	4,239	7,313**

Such an index computed below expresses the minimum index of performance in regard to national income.

$$\frac{1{,}583^{*}}{1{,}192} = 1.3$$

Another index of performance gives a relative measure of the contribution that the Royal Glen Project development would make to the objective of expanding employment in the Appalachian Region. The numerator consists of increased wage payments for construction and operation of the water project plus wage and salary flows to the region generated by the associated private investments. The denominator is the annual cost, both public and private, necessary to provide the expansion in employment opportunities.

$$\frac{7{,}313^{**}}{5{,}228} = 1.4$$

22. ALLOCATION OF COST

Costs of the Royal Glen Project were allocated by the separable cost remaining benefits methods modified to accommodate regional income expansion as a purpose. Purposes among which costs are allocated include flood control, recreation, and regional income expansion. Table 3-28 summarizes the construction expenditures, annual operation, maintenance and major replacements costs, total capital and investment cost, and annual charges. Cost allocation is given in table 3-29.

Alternative Costs

The SCRB method of cost allocation provides that allocated costs should be limited by the lower of either the benefits or the alternative costs providing each purpose. The alternative cost for flood control, as summarized in table 3-28, was based on actual estimate for a single-purpose flood control project at the site selected for the multipurpose reservoir and accompanying channel improvement. The alternative costs for recreation were developed from statistical data compiled by the Corps of Engineers reflecting costs of single-purpose recreation development undertaken by state parks in Ohio River Basin states as shown below:

Alternative Costs of Recreation

Average visitation

General - 480,000 x .8789 =	422,000
F&W	23,100
TOTAL	445,100

Area	Acres
Pool	1,150
Specific Recreation Lands	740
Joint use lands (1/3 x (2900 - 1150))	580
TOTAL	2,470

Visits/acre 445,100 - 2470 = 180

Alternative Cost/visitor day = $0.61 (1960 price level ENR = 823.0)
$0.85 (1968 price level ENR = 1154.0)

Alternative Costs

480,000 x $0.85 x 0.76 =	$310,000
23,100 x 0.85 =	20,000
TOTAL	$330,000

TABLE 3-28
SUMMARY OF COSTS ($1,000)
ROYAL GLEN PROJECT, W. VA.
(3½% - 100 years)

	Specific Use Lands & Facilities			Joint Use		Alternative Single Purpose Projects		Multiple Purpose Project Less		
	Flood Control	Recreation	Regional Income Expansion	Lands & Facilities	Total Costs	Flood Control	Recreation	Flood Control	Recreation	Regional Income Expansion
Construction First Costs										
Lands & Damages		150		2570	2720					2720
Relocations				3065	3065					3065
Reservoir Clearing				360	360					360
Dam & Appurtenances				16842	16842					16842
Recreation Facilities (initial)		2130			2130					2130
Channel Improvement	1338				1338					1338
Building, Grounds & Utilities				340	340					340
Permanent Operating Equipment				105	105					105
Fish & Wildlife Mitigation				70	70					70
Beautification				540	540					540
Total, Initial	1338	2280	-	23892	27510	21200	-	25120	22410	27510
Future Recreation Facilities	-	1570	-	-	1570	-	-	1570	-	1570
Total Construction Cost	1338	3850	-	23892	29080	21200	-	26690	22410	29080
Development Costs	-	-	178298	-	178298	-	-	178298	178298	-
Total	1338	3850	178298	23892	207378	21200	-	204988	200708	29080
Investment Costs										
Initial Construction Costs	1338	2280	-	23892	27510	21200	-	25120	22410	27510
Interest during Construction	108	74	-	1941	2123	1722	-	2041	1821	2123
Investment Cost, Initial	1446	2354	-	25833	29633	22922	-	27161	24231	29633
Future Recreation Facilities	-	1570	-	-	1570	-	-	1570	-	1570
Developmental Costs	-	-	178298	-	178298	-	-	178298	178298	-
Total	1446	3924	178298	25833	209501	22922	-	207029	202529	31203
Annual Financial Charges										
Initial Investment	-	-	-	-	-	-	-	-	-	-
Interest & Amortization	49	80	4036	875	5041	777	-	4956	4857	1005
Operation & Maintenance	-	-	-	-	-	-	-	-	-	-
Recreation	-	48	-	-	48	-	-	48	-	48
Dam	-	-	-	30	30	30	-	30	30	30
Major Replacement	-	-	-	-	-	-	-	-	-	-
Recreation	-	19	-	-	19	-	-	19	-	19
Dam	-	-	-	20	20	17	-	19	19	20
Total	49	147	4036	925	5158	824	-	5072	4906	1122
Future Increment (discounted)	-	-	-	-	-	-	-	-	-	-
Interest & Amortization	-	29	-	-	29	-	-	29	-	29
Operation & Maintenance	-	26	-	-	26	-	-	26	-	26
Major Replacements	-	7	-	-	7	-	-	7	-	7
Total	-	62	-	-	62	-	-	62	-	62
Total Annual Financial Costs	49	209	4036	925	5220	824	330	5134	4906	1184

TABLE 3-29
ALLOCATION OF COSTS ($1,000)
ROYAL GLEN PROJECT & DEVELOPMENTAL PLAN, W. VA.

Item	Flood Control	Recreation	Regional Income Augmentation	Total
1. Benefits	878	581	7,313	-
2. Alternative Costs	824	330	5,220	8,772
3. Benefit Limit	824	330	5,220	8,772
4. Separable Costs	86	314	4,036	4,436
5. Remaining Benefits	738	16	1,184	1,938
6. Ratio of Line 5	.381	.008	.611	1.000
7. Allocated Joint Costs	299	6	479	784
8. Total Allocated Costs (annual financial)	385	320	4,515	5,220
Allocation of OM & MR Costs				
9. Separable OM & MR	1	100	-	101
10. Allocated Joint Costs	19	-	30	49
11. Total Allocated OM & MR	20	100	30	150
Allocation of Investment Costs				
12. Annual Investment Costs	365	220	4,485	5,070
13. Capitalized Investment Cost	10,773	6,455	191,551a/	208,779
14. Adjustment for Discount	-	722b/	-	722
15. Total Allocated Investment Cost	10,773	7,177	191,551	209,501
Allocation of Construction Costs				
16. Investment in Specific Use Facilities & Lands	1,446	3,924	178,298	183,668
17. Investment in Joint-Use Facilities & Lands	9,327	3,253	13,253	25,833
18. Interest on Joint-Use Facilities & Lands	701	244	996	1,941
19. Construction Cost of Joint-Use Facilities & Lands	8,626	3,009	12,257	23,892
20. Construction Cost of Specific Use Facilities & Lands	1,338	3,850	178,298	183,486
21. Total Allocated Construction Costs	9,964	6,859	190,555	217,378
22. Less Developmental Costs	-	-	178,298	178,298
23. Total Allocated Costs, Royal Glen Project	9,964	6,859	12,257	29,080
24. Percent Allocated by Purpose	34	24	42	100

a/ $(4485 - 4036) \times \frac{1}{.03388} = 13,253 + 178,298 = 191,551$

b/ $1570 \times (1-.5401) = 722$

The value assigned as an alternative cost for regional income expansion is not based on a relevant alternative program for providing similar income effects, because the full range for alternative means for obtaining these benefits have not been evaluated. To maintain the principal of the SCRB cost allocation procedure, the total cost of the water project and associated costs have been entered as a limit on cost to be allocated to regional income expansion.

Separable Costs

The incremental cost for adding each purpose to the multiple-purpose project was calculated by estimating the savings which would accrue if that purpose were omitted and all other purposes were maintained in the project.

Joint Costs

Joint costs were allocated to each purpose according to the ratio of benefits remaining after separable costs were allocated.

Recreation Costs

The costs allocated to recreation have been sub-allocated between general and fish and wildlife recreation programs in table 3-30.

TABLE 3-30
ROYAL GLEN PROJECT
RECREATION - SUB-ALLOCATION
BETWEEN GENERAL AND FISH AND WILDLIFE

Separable Cost of Recreation	($1,000)
Cost of multiple purpose project	29,080
Cost of MP project less Recreation	22,410
Separable Costs of Recreation	6,670
Lands	150
Facilities	3,700
Storage	2,820
TOTAL	6,670

Sub-allocation of Recreation Costs

Recreation	Benefits	Ratio	Separable Costs ($1,000)
General	553	.952	6,350
F&W	28	.048	320
	581	1.000	6,670

SECTION VII - COST SHARING

23. APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS

Flood Control

All costs allocated to flood control have been apportioned to the Federal Government in accordance with established policy. Flood control benefits are distributed along about 68 miles of the South Branch Potomac River. As previously discussed, the channel improvement features are included as an integral part of the reservoir project and are considered subject to similar cost sharing criteria, because the design offers the least costly means of attaining an acceptable degree of flood protection in Petersburg, given the constraints imposed on inundation of the Smoke Hole Caverns and maximum preservation of the scenic attributes of the area.

Non-Federal interests would be required to bear the cost of lands and easements required for the channel improvement. The cost for the lands is currently estimated at about \$50,000. Maintenance of the channel improvement would also be a non-federal responsibility and is estimated at about \$2500 annually.

Recreation

All costs allocated to recreation for Royal Glen Dam and Reservoir are apportioned to the Federal Government according to the Federal Water Project Recreation Act (P.L. 89-72). This act states:

> "That it is the policy of the Congress and the intent of this Act that . . .(c) project construction agencies shall encourage non-Federal public bodies to administer project land and water areas for recreation . . . unless such areas . . . are appropriate for administration by a Federal agency as a part of the national forest system. . ."

The recreation areas at Royal Glen Reservoir would be appropriate for administration by a Federal agency as a part of the National Forest system. The Corps of Engineers, the U.S. Forest Service and USDA, will cooperatively plan the recreation development and the Forest Service will construct recreation facilities and administer all of the land and water recreation areas of the Royal Glen Reservoir project. The Forest Service will also be responsible for planning and constructing additional recreation facilities as required by the future demand for expansion.

Regional Income Expansion

All costs allocated to regional income expansion have been apportioned to the Federal Government.

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SECTION VIII - COORDINATION IN PLANNING

24. FEDERAL AGENCIES

During planning, studies were coordinated with the Federal Departments of Agriculture, Commerce, Interior, and Health, Education and Welfare; the Federal Power Commission, and the Appalachian Regional Commission, either directly by the Baltimore District, Corps of Engineers, or through the Water Development Coordinating Committee for Appalachia (WDCCA), as appropriate.

The proposed Royal Glen Project is compatible with the plans contained in the Office Chief of Engineers report on the Potomac River Basin.

Many Federal agencies such as the U.S. Geological Survey, Environmental Science Services Administration, and the Office of Business Economics provided basic data for the project planning, such as climatologic, streamflow, economic records, through regular publications or special reports. Other Federal agencies participated indirectly by assisting the State and local agencies in planning groups.

Several agencies made special studies as an aid in formulation of evaluation of the plan of development for the Royal Glen Project. Reports of these agencies are included in the appropriate indices to this Report. The following paragraphs concern certain recommendations or views by participating agencies and the actions taken.

The Bureau of Outdoor Recreation surveyed the recreation market area to determine that the demand for recreation opportunities, present and future, exceeds the capabilities of other recreation developments of the project area. They estimated that, at ultimate development, 480,000 recreation days annually could be expected. The Bureau stated that the unique scenic qualities of the area together with the availability of alternate locations in providing recreation water, combined to raise the question as to the appropriateness of an impoundment at the Royal Glen site and further indicated that the complete compatibility of the project with the overall management objectives of both the Spruce Knob-Seneca Rock National Recreation Area and the entire Potomac Basin must be demonstrated before a sound conclusion could be reached.

The proposed management plan for the Spruce Knob-Seneca Rock NRA includes consideration of a slackwater recreation impoundment at Royal Glen. There are no more desirable alternatives which would meet the developmental needs of this portion of the Appalachian Region while maintaining the high scenic and natural values of the area. The proposal is considered to be an appropriate component of the comprehensive water resources development plan of the Potomac River Basin.

The Bureau of Sports Fisheries and Wildlife evaluated the fish and wildlife conservation and enhancement aspects of the Royal Glen Project and their report is included in Appendix G in this report.

The Bureau concludes that the net gains in fishing opportunities is not adequate to offset the high quality fish and wildlife recources and aesthetic values which would be lost and therefore (the Bureau) cannot endorse the project in the interest of fish and wildlife conservation. The Bureau further concludes, that in the event that the project is authorized for other overriding consideration, that additional measures should be incorporated into project plans which will achieve full realization of fishing and hunting potentials associated with the project.

The portions of the North Fork and the South Branch Potomac River which provide high quality fishing opportunities are generally located upstream of the conservation pool limits. The reaches of the streams inundated by the pool are not considered to provide the high quality opportunities available upstream due to the existing development along the stream banks, particularly the North Fork.

In relation to the Bureau's recommendations, the following features are incorporated into the Royal Glen Project:

A minimum reservoir release of 100 cfs year round and 360 cfs during April and May will be provided. The Bureau recommendations of 250 cfs from 1 April through 31 October and 100 cfs from 1 November through 31 March cannot be satisfied without a substantial increase in the size of the conservation pool. Formulation to meet this requirement would necessitate increasing the size of the project and would adversely affect the existing high scenic and natural values which the proposed project has been formulated to preserve. Based on the record period of 1928-1960, the adopted regulation would provide augmentation over natural flows in 33 months or about 13 percent of the low flow months of May - October.

Fisherman access will be provided to the tailwater area with parking facilities provided. According to the Bureau, additional downstream access would provide incremental additional benefits only if minimum releases are increased to 250 cfs.

The design of the multi-level outlet works and plans for clearing and widening the stream channel will be coordinated with the West Virginia Department of Natural Resources and with the Bureau of Sport Fisheries and Wildlife.

A reservoir zoning plan will be developed and coordination with the West Virginia Department of Natural Resources, Bureau of Outdoor Recreation, the Bureau of Sport Fisheries and Wildlife, and the Forest Service.

Location of wildlife mitigation lands will be determined cooperatively by the West Virginia Department of Natural Resources, U.S. Forest Service, the Corps of Engineers, and the Bureau of Sport Fisheries and Wildlife.

Wildlife management practices on project lands will be carried out by both the U.S. Forest Service and the West Virginia Department of Natural Resources under terms of a cooperative agreement, now in effect between the two agencies.

The objectives of the National Park Service are:

(a) Preservation and enhancement of areas of unique scenic, archeological, historic, and natural science values.

(b) Improvement of land and water quality management.

(c) Consideration of structural and non-structural measures. beneficial flow regulation, and flow regulation storage.

In addition to the above; Public Law 89-665, the National Historic Preservation Act of 1966 requires that any Federal or Federally assisted undertaking in any state take into account its effect on any historic site or structure listed in the National Register of Historic Places. The National Register of Historic Places is a list of properties significant to the nation, to the states, and to local areas because of significance in history, architecture, archaeology, and culture.

Studies by the National Park Service to carry out these objectives will be requested by, and coordinated with the appropriate office having responsibility for construction of this project. These studies will be requested when advanced engineering and design for the project is initiated.

The FWPCA has evaluated the need for water quality control releases from the proposed Royal Glen Reservoir and concluded there was no present nor projected need for reservoir storage for water quality control (see Appendix D, Water Supply and Water Pollution Control).

25. STATE AGENCIES

Coordination has been maintained throughout the course of these studies with the West Virginia Department of Natural Resources, the West Virginia Department of Commerce, and with the Governor's representative to the Water Development Coordinating Committee for Appalachia. Views of State of West Virginia are included in attached letter from Governor Moore dated 8 September 1969. (See Exhibit 3-21.)

26. PUBLIC HEARINGS

A public hearing was held at Moorefield, West Virginia prior to the publication of the Potomac River Basin Report (1963). Intense opposition was expressed by those interest groups concerned with the preservation of the natural and scenic resources of the area. The current proposal has been substantially reformulated from that presented at the earlier hearing, in order to provide maximum preservation and protection of the natural and scenic resources of the area.

A public hearing was held in Petersburg, West Virginia on 25 August 1969, at which approximately 250 were in attendance. Local representatives traced the history of flooding and expressed the need for flood protection at Petersburg as a stimulant to economic expansion. Representatives of the Izaak Walton Leaque and the West Virginia Highlands Conservancy, Sierra Club, West Virginia Wild Water Association and the Canoe Cruisers Association expressed opposition to the project. Grant County Land Owners Association opposed the project, stating that they were not convinced that the modified project would be built, but that the original 1963 project would eventually be built.

The local representative to the state legislature recognized the need for flood protection in the area. A petition from approximately 50 downstream residents, in the vicinity of Moorefield, was introduced in favor of the Royal Glen project.

STATE OF WEST VIRGINIA
OFFICE OF THE GOVERNOR
CHARLESTON 25305

ARCH A. MOORE, JR.
GOVERNOR

September 8, 1969

Colonel W. J. Love
District Engineer
U. S. Army Corps of Engineers
Post Office Box 1715
Baltimore, Maryland 21203

Dear Colonel Love:

This letter is in reference to the proposed U. S. Army Corps of Engineers' Royal Glen Project, Grant County, West Virginia, and an expression of the interest of the State of West Virginia in that project.

The West Virginia Department of Natural Resources, with concurrence from the Office of Federal-State Relations, presented a statement to the Corps of Engineers at the public hearing held in Petersburg, West Virginia, on August 25, 1969. This letter supplements that statement and reflects the total State attitude toward development of this project.

With the development of a flood control program above the Town of Petersburg, West Virginia, unquestionably, substantial economic benefits will accrue to downstream areas--benefits including flood control, increased recreational opportunities, and opportunities for industrial development.

It is also noted that the proposed project is located entirely within an area designated as a National Recreational Area, and an area possessing high natural values. Consequently, with the completion of the project, it is recognized that certain alterations would occur, including the attraction to the area of broadwater recreation users, and unalterable changes in the natural environment.

The suggestions contained in the presentation at the August 25 hearing by the West Virginia Department of Natural Resources are worthy of additional consideration in further development of project plans. These include: increasing minimum releases from the proposed reservoir from 100 c.f.s. to 200 c.f.s. to enhance downstream recreational opportunities; modification of the channel improvement

Sheet 1 of 2
Exhibit 3-21

design to lessen adverse impact on aquatic habitat in the affected area; establishing a conservation pool level to eliminate the inundation of the unique segment of the Smoke Hole Country and the famous Smoke Hole Caverns; and acquiring downstream access sites to enhance boating, fishing, and other recreational opportunities.

The State of West Virginia urges the U. S. Army Corps of Engineers to continue with detailed studies of the Royal Glen proposal, with the thought of developing a proposal that will properly accommodate all of the interests associated with a project of this kind.

Sincerely yours,

Arch A. Moore Jr.

Arch A. Moore, Jr.
Governor

AAMJr:rs

Sheet 2 of 2
Exhibit 3-21

REPORT FOR DEVELOPMENT

OF

WATER RESOURCES IN APPALACHIA

PART III - PROJECT ANALYSES

CHAPTER 4

HIPES RESERVOIR PROJECT

JAMES RIVER BASIN

VIRGINIA

Office of Appalachian Studies

Corps of Engineers

September 1969

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PART III

PROJECT ANALYSES

CHAPTER 4 - HIPES RESERVOIR PROJECT

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LIST OF TABLES (cont'd)

LIST OF TABLES (cont'd)

CHAPTER 4 - HIPES RESERVOIR PROJECT

LIST OF EXHIBITS

CHAPTER 4 - HIPES RESERVOIR PROJECT

LIST OF EXHIBITS (cont'd)

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PART III
PROJECT ANALYSES

CHAPTER 4 - HIPES RESERVOIR PROJECT

SECTION I - SUMMARY

1. PHYSICAL DESCRIPTION

Hipes multiple purpose reservoir site is primarily located in Botetourt County, Virginia, about 25 miles north of Roanoke. This site, located in the Valley and Ridge Physiographic Province, is entirely within Jefferson National Forest. The project, with a 172-foot high dam located 14.8 miles up Craig Creek, would control 327 square miles of drainage area in the headwaters of the James River Basin. The location is shown on Exhibit 4-1.

Major physical features of the project would be the 2,400-foot long earth fill dam; a gated spillway with three 50-foot wide gates; and a reservoir having a total storage capacity of about 305 thousand acre feet (17.5 inches runoff from the contributing drainage area). Associated with the reservoir project would be a trout rearing station located immediately below the dam, and six public access sites spaced along Craig Creek between the dam and the stream mouth, primarily for fishermen.

2. PROJECT IMPACTS

The reservoir project has been planned to provide the services needed to satisfy the water related needs of the area, and thereby encourage development of the James River Basin both in and outside of the Appalachian Region. The specific benefits realized from the project would be:

a. Flood damage reduction

b. Water pollution control

c. Fish and wildlife enhancement

d. Outdoor recreation

e. Economic development

The disastrous storm of August 1969 which centered approximately 35 miles from the project site and which caused a loss of over 100 lives in addition to monetary losses in excess of $100 million in the James River Basin, points to the need for a project such as Hipes.

Flood damages would be virtually eliminated along the lower 14.8 miles of Craig Creek. Hipes, operating in a system with the Gathright

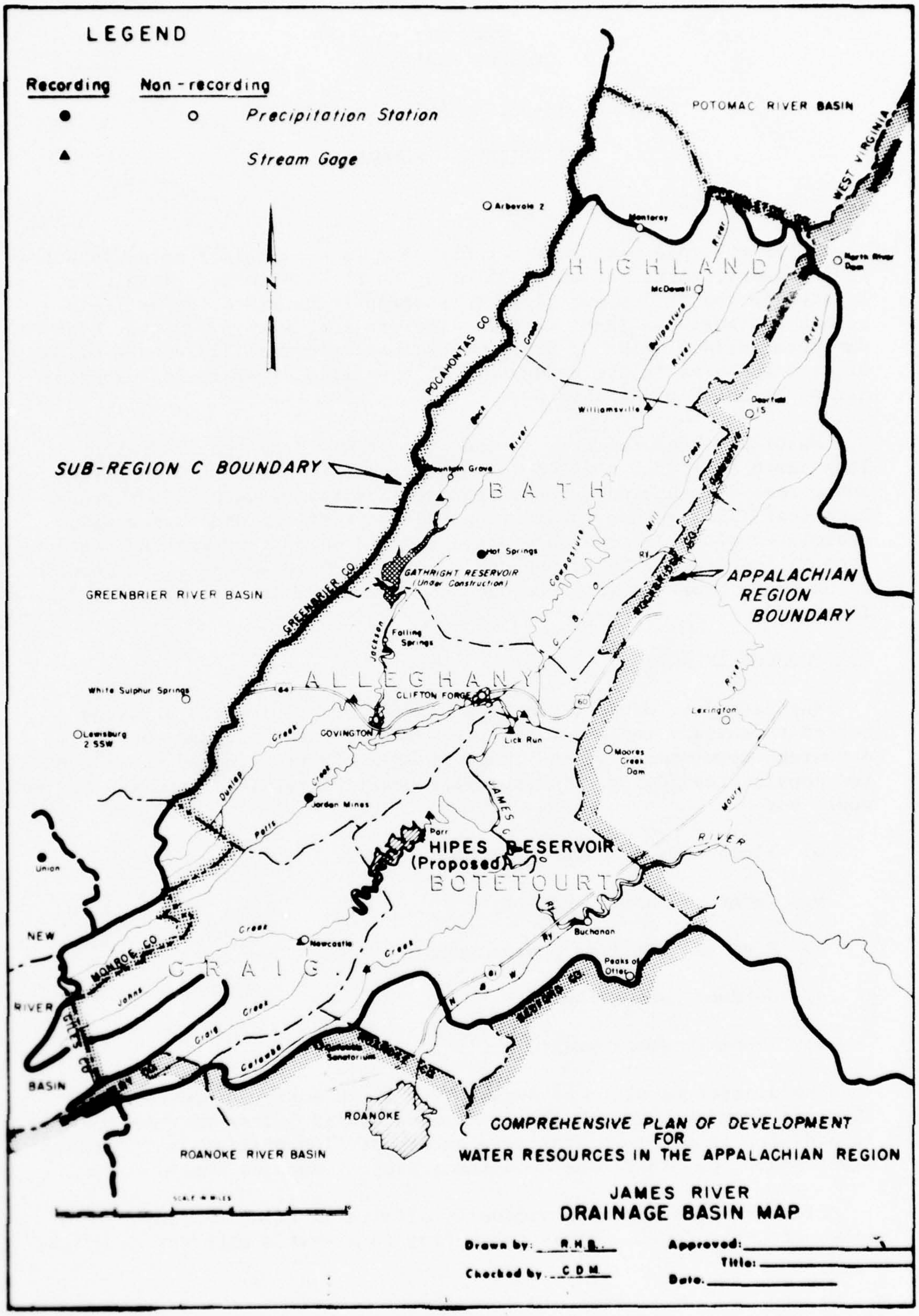

LEGEND
Recording
Non-recording
Precipitation Station
Stream Gage
N
SUB-REGION C BOUNDARY
APPALACHIAN REGION BOUNDARY
POTOMAC RIVER BASIN
WEST VIRGINIA
HIGHLAND
BATH
ALLEGHANY
BOTETOURT
CRAIG
POCAHONTAS CO.
GREENBRIER CO.
MONROE CO.
GREENBRIER RIVER BASIN
NEW RIVER BASIN
ROANOKE RIVER BASIN
ROANOKE
GATHRIGHT RESERVOIR
(Under Construction)
HIPES RESERVOIR
(Proposed)
JAMES RIVER
Monterey
McDowell
Williamsville
Hot Springs
Falling Springs
White Sulphur Springs
Lewisburg 2 SSW
CLIFTON FORGE
COVINGTON
Lick Run
Lexington
Moores Creek Dam
Jordan Mines
Newcastle
Buchanan
Peaks of Otter
Union
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
JAMES RIVER
DRAINAGE BASIN MAP
Drawn by: R.H.B.
Checked by: C.D.M.
Approved:
Title:
Date.

Exhibit 4-1

Reservoir, would reduce the flood hazard along the James River as far downstream as Lynchburg, Virginia - a distance of 66 miles. Approximately one-third of the reservoir storage would be used to improve the quality of flows along Craig Creek, and along the James River as far as Lynchburg and Richmond. Fish from the proposed Hipes trout rearing station have the potential to supply approximately 112,500 man-days of additional trout fishing opportunity annually to Virginia fishermen. A net gain of 75,300 man-days of fishing annually are estimated for the controlled, stocked reservoir having a nominal surface area of 4,540 acres; through the supporting facilities and access points around the reservoir; and downstream along the 14.8 miles of tailwaters. (See Appendix G, Pages G-211-G-212). Limited hunting would be permitted wherever it would be consistent with safety of other recreationists and where adequate game is available. General outdoor recreation in this naturally scenic area would be similarly improved for about 925,000 users by developing nine areas around the reservoir. (See Appendix F, Page F-90). Economic development of the area of influence of the project would be supported through provision of additional job opportunities, both during and after project construction.

3. COST AND BENEFITS

Costs for constructing Hipes Reservoir, downstream access sites, and the trout rearing station are estimated at $23.5 million (which includes $7000 for archeological survey and salvage). Annual charges are estimated to be $1,199,000. Comparable values for associated investments are $1.6 million with an annual equivalent of $89,000. Annual benefits for the development are estimated as follows:

	INCOME	
	National	Regional
Users	$1,999,000	$ 582,000
Expansion Effects		
Redevelopment	128,000	369,000
Development	175,000	773,000

Using the preceding, the index of performance for the objective of increasing national income would be 1.8, and for increasing regional income, 0.9 (See Section VI, par. 22).

4. COOPERATION REQUIRED FOR CONSTRUCTION

In accord with present Federal policy, costs of the Hipes Reservoir and its appurtenances would be apportioned to Federal agencies. The Corps of Engineers would construct and operate the project, in cooperation with the Forest Service of the U.S. Department of Agriculture, which has agreed to develop and operate the nine recreation areas surrounding the reservoir, and to share in construction costs thereof.

Construction costs of the associated downstream fishery and trout rearing station would be equally apportioned between Federal and non-Federal interests. A non-Federal agency, specifically the Virginia Department of Conservation and Economic Development, has expressed willingness to assume non-Federal obligations, including maintenance and operation costs of these project features.

Prior to construction, local interests should furnish assurances of establishment of downstream encroachment lines to permit efficient reservoir operation; contribute to pollution control by providing adequate treatment or other waste control methods; and, to the full extent of their legal capability, exercise control against diversion of streamflow available for water quality control.

5. NEEDS THAT POTENTIALLY CAN BE MET BY DEVELOPMENT OF WATER RESOURCES

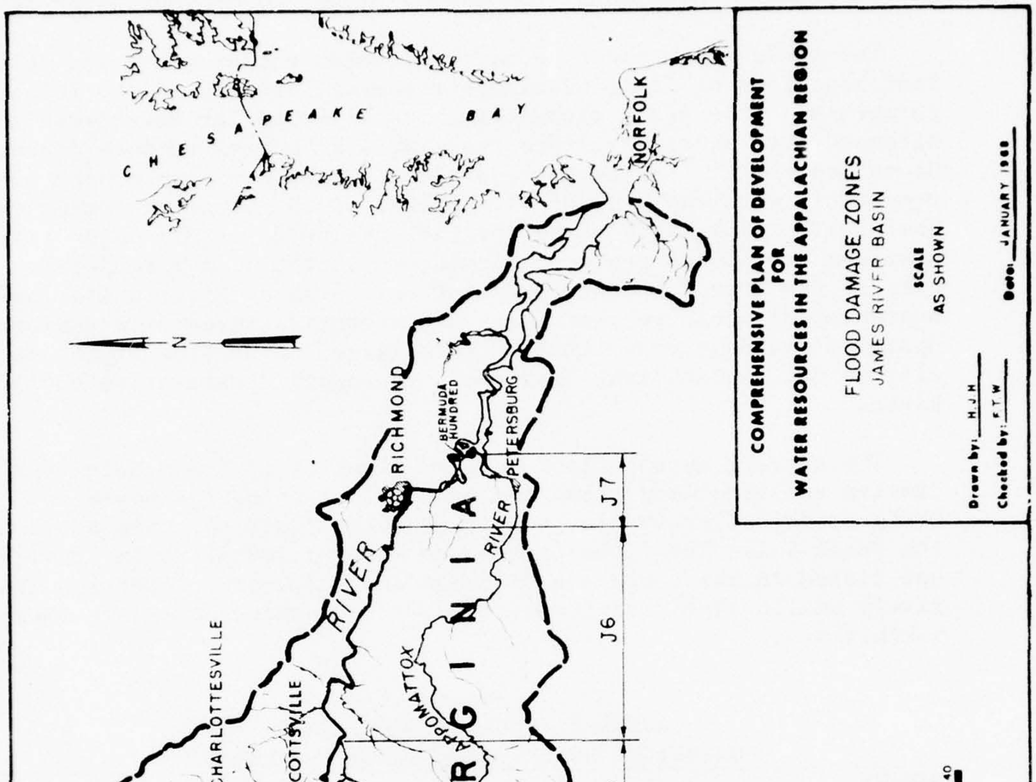
The needs which could be met by development of water and related land resources of Craig Creek are discussed briefly in the following paragraphs. The needs along the James River as far downstream as Richmond are described, since they could be served to some degree by Hipes Reservoir. Furthermore, projects which may be proposed must be compatible with the plan of development of the water resources of the basin. To insure such compatibility, the needs on all major tributaries upstream from Lynchburg were considered in the plan formulation. Lynchburg is the furthest upstream point on the James River where low-flow augmentation would be beneficial and potential reservoirs anywhere upstream would be competitive alternatives. A portion of the needs will be met by Gathright Reservoir, now under construction on Jackson River.

The average annual flood damages along Craig Creek below the Hipes damsite and remaining along the James River below the mouth of Craig Creek, after completion of Gathright Reservoir, are shown in the Table 4-1. The flood damages on major tributaries in Sub-region C not listed in the table are to crops and a few structures and are relatively small. The location of streams and damage zones are shown on Exhibit 4-2.

TABLE 4-1
AVERAGE ANNUAL FLOOD DAMAGES -
GATHRIGHT RESERVOIR ASSUMED IN OPERATION

DAMAGE ZONE	----	TO	DAMAGES (a)
	James River		
J2	Craig Cr.	Maury R.	$ 40,000
J3	Maury R.	Fishing Cr.	136,000
J4	Fishing Cr.	Rockfish R.	72,000
J5	Rockfish R.	Slate R.	94,000
J6 and J7	Slate R.	Richmond	More than $ 1,000,000
	Craig Creek		
C1	Hipes Damsite	Mouth	9,000

(a) Includes allowance for future development of flood plain which is expected to occur in the absence of flood control projects.


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
FLOOD DAMAGE ZONES
JAMES RIVER BASIN
SCALE
AS SHOWN
Drawn by: HJH
Checked by: FTW
Date: JANUARY
SCALE IN MILES
10 0 10 20 30 40
CHESAPEAKE BAY
NORFOLK
RICHMOND
BERMUDA HUNDRED
PETERSBURG
CHARLOTTESVILLE
SCOTTSVILLE
APPOMATTOX
RIVER
JAMES
VIRGINIA
SLATE R.
ROCKFISH R.
HOWARDSVILLE
BUENA VISTA
GLASGOW
LYNCHBURG
MAURY R.
APPALACHIAN REGION BOUNDARY
COWPASTURE RIVER
CLIFTON FORGE
EAGLE ROCK
COVINGTON
CRAIG CR.
GATHRIGHT RES.
HIPES RES. (PROPOSED)
C1
J2
J3
J4
J5
J6
J7
M1

Sufficient relatively flat land is available to accomodate the projected industrial, commercial, and residential expansion. Flood protection would permit more intensive agricultural use of the flood plains.

Available streamflow, augmented by anticipated releases from Gathright Reservoir, will be adequate to maintain water of suitable quality in the Jackson and James Rivers.

Information on water supply and water quality control needs was furnished by the Federal Water Pollution Control Administration (FWPCA) (See Appendix D). Flows required in the Jackson and James River for water quality control, after adequate treatment of wastes at their source, are shown in Table 4-3. These are far in excess of the natural summer flows. Gathright Reservoir will supply the needs at Covington to about year 2020, and at Lynchburg and Richmond to about year 1980. Elsewhere in the basin, upstream from Lynchburg, there is no known need for low-flow regulation for water quality control. Augmentation of flows by releases from Gathright and Hipes Reservoirs would have no significant effect on salinity in the estuary of the James River.

Improvement of streams primarily for navigation is not considered practical in the upper James River Basin. However, navigation consisting of recreational craft can be expected to develop in any large reservoirs created in the area.

The Federal Power Commission (FPC) has indicated a large demand for power in Sub-region C and the surrounding area. Power generated at reservoir projects in the area would be marketed by the Southeastern Power Administration. The project is located in Power Supply Area 18. The exhibit showing this area and the forecast prepared by the FPC are presented in Appendix B. This forecast indicates that the maximum demand for power will increase by about 6.4 million kilowatts in the 1970 decade and by greater amounts in subsequent years. A portion of this need could be supplied by conventional or pumped storage hydropower.

The need for water-based recreation opportunity in Sub-region C is expected to increase rapidly in the foreseeable future. Development of water-based recreational areas along Craig Creek would provide residents and visitors with additional recreation opportunities in the Jefferson National forest and thereby provide an important financial income to inhabitants of the region.

The need for water for irrigation, based on estimates by counties furnished by the Soil Conservation Service (SCS) is indicated in Table 4-2.

TABLE 4-2
ANNUAL IRRIGATION NEEDS IN ACRE FEET

Year	Upstream From Lynchburg	Upstream From Richmond
1980	4,200	17,900
2000	9,500	47,300
2020	16,000	87,500

About 60 percent of the water required is expected to be taken from farm ponds and the remainder from streams. The natural streamflow is in excess of irrigation needs. Because of soil conditions in the irrigated areas, little return flow is expected.

6. ALTERNATIVES AVAILABLE FOR MEETING THE NEEDS

Economy in the use of the Nation's resources requires that no funds be expended in the development of a plan which would provide benefits which could be provided at less cost by alternative means. This is in conformance with Senate Document No. 97, 87th Congress, entitled: "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources."

The following alternatives have been considered, individually and collectively, as appropriate:

a. Structural

(1) Local flood protection works.
(2) Flood proofing.
(3) Reservoirs on small streams.
(4) Forest management and land treatment programs.
(5) Diversion of waste to larger streams.
(6) Lagooning of waste and discharge thereon during periods of high streamflow.
(7) Instream aeration.
(8) Advanced waste treatment.
(9) State-park type recreation areas.
(10) Reservoirs on major streams.

b. Non-structural

(1) Flood plain regulation.
(2) Flood warning system.
(3) Evacuation of the flood plain.

Investigation was made of localities subject to flooding along the James River to determine the possibility of developing an economically feasible plan of protection by the construction of levees, walls, pumping stations, and channel improvements as a primary means of flood control. The flood damage statistics for the cities and towns along the James River were examined with a view to segregating those areas in which flood damages were confined to a reasonably concentrated section and wherein local flood protection might prove to be economically justified. Local flood protection works were investigated at Glasgow, Lynchburg, and Scottsville. Such projects would have the disadvantage of leaving other areas vulnerable, as well as restricting the area rendered suitable for development. Preliminary investigations indicated that damages at other localities, such as at Buchanan, were not sufficiently large or concentrated to warrant detailed study. The studies clearly indicated that such local measures along the entire James River downstream to Scottsville lacked economic feasibility. Since Hipes Reservoir would protect extensive tracts along Craig Creek and other reaches of the James River, in addition to the urban areas, it was evident that there was no feasible alternative to the flood control provided by Hipes Reservoir. On the tributaries in Sub-region C, there are no areas where flood damages would justify local protection works.

Flood proofing is not deemed to be an economically feasible measure of protection to agricultural development, to utilities such as railroads and highways, or to the large numbers of properties on the flood plain. However, it should be given careful consideration by individuals owning or planning buildings on the flood plain.

Analyses by the U.S. Department of Agriculture show that reservoirs in small watersheds are effective and economically feasible for the control of floods on some headwater streams. However, reservoirs in small watersheds would not be as efficient in providing the same degree of protection for flood plain areas along the James River, or in providing the necessary increase in low flows, as potential reservoirs on large streams. Cost comparisons indicate that storage dispersed in smaller projects would probably cost from $150 to $200 per acre foot on an installation basis whereas the unit cost in a single large reservoir in this area would be about 75 dollars. Forest management and land treatment programs increase the amount of rain which soaks into the land. However, the effect on floods which result when large amounts of rain occur would be minor.

The FWPCA has investigated methods of meeting water quality control needs. It has concluded that instream aeration, waste storage, and piping of waste to bodies of water having a greater assimilative capacity do not presently appear to be feasible devices for pollution control along the James River in the Lynchburg and Richmond areas. Advanced treatment is a practical alternative and has been considered for meeting water quality needs at Richmond instead of dilution. Advanced treatment in conjunction with flow augmentation was determined to be the most feasible solution.

In the case of recreation, the problem is to select the least costly alternative plan for providing a recreation experience equivalent to the water-oriented recreation that would be made available through construction of a major reservoir. A state park type facility is considered to be the least costly alternative. For further details, see Section VI of this chapter.

Flood plain regulation is particularly useful where damages are widely scattered, as they are along the James River, and where other measures are ineffective or uneconomical. Regulation is essentially a measure for controlling the use of flood plain by prevention of channel encroachment, by zoning to regulate the use of the flood plain, by reconstruction of structures in the flood plain to be resistant to flood hazards, by development of evacuation plans, and by making the public aware of the flood hazard in these areas. The execution of any effective flood plain regulation program is encumbered by individual property rights, economic pressures, enforcement problems and lack of public awareness. In the James River Basin to date, there has been little experience in this form of regulation. Much more consideration should be given to this measure by local interests as a practical solution to flood problems. The adoption of such measures by local interests, in many instances, would materially reduce flood damage potential. To aid local communities in planning and regulating the use of flood plains, flood plain information studies are currently underway for the Jackson River from the Gathright Damsite to its mouth. A study has also been authorized for the James River in Botetourt County.

A flood warning system related to the rate of potential flooding in the basin would be of great value in reducing loss of life and monetary damage through evacuation of people and movable property from flood plains. It is a valuable supplement to structural measures for flood damage reduction but not a substitute therefor.

The total value of development on the flood plain is estimated at 150 million dollars. Evacuation of railroads, utilities, and other developments from the flood plain is not deemed to be practical.

Evaluation of Benefits and Costs - A comparative evaluation of benefits and costs was made during plan formulation for each project considered. The needs which could be satisfied by the construction of a major reservoir at alternative sites are flood control, water quality control, recreation, and power generation. In addition to these purposes, consideration was given to the impact on local economy by creating new employment opportunity in the area, and on the national economy by providing employment to workers who would remain unemployed or underemployed in the absence of the project.

Studies made to determine the nature and magnitude of needed products of water resource development have already been presented. A discussion of each of the benefits, the monetary value thereof, and the effect of operational and other requirements on a reservoir project

in providing them are presented in the following paragraphs. All benefits were converted to an equivalent average annual amount in the 100-year period beginning in 1980, using an interest rate of 3-1/4 percent.

Flood control benefits were determined as the difference between the estimated average annual damages for the affected flood damage reaches below a given project, with and without the project. These average annual flood control benefits were then adjusted to reflect normal trends of physical development in the flood damage reaches under "without project" conditions. Flood damage data on which the benefits are based were developed for the main stem and major tributaries by the Corps of Engineers except for agricultural damages which were developed by the Department of Agriculture. Damage data are presented in detail in Section V of this chapter. Gathright Reservoir, now being constructed on the headwaters of the Jackson River, will reduce the average annual damages along the Jackson and James Rivers, and this has been taken into account in the analyses of benefits.

An investigation of the benefits of storage in a proposed reservoir for low flow augmentation for water quality control has been made by the FWPCA. The report on FWPCA is included in Appendix D. The report indicates that water of objective quality would be prohibitively expensive in the vicinity of Lynchburg and Richmond now or in the foreseeable future by adequate treatment of wastes at their source (secondary treatment operated at an efficiency of 85 percent removal of five-day BOD). Objective quality can be provided by supplementing adequate treatment by low-flow augmentation.

The flow required to maintain suitable water quality, with adequate treatment at the source, is given in Table 4-3.

TABLE 4-3
FLOW REQUIRED FOR WATER QUALITY CONTROL (CFS)

	Lynchburg				Richmond			
Month	Present	1980	1995	2020	Present	1980	1995	2020
Jan	220	230	300	320	(a)	(a)	300	400
Feb	240	260	300	380	(a)	(a)	300	400
Mar	290	300	370	450	(a)	(a)	300	500
Apr	420	440	550	650	(a)	(a)	650	950
May	460	480	620	720	(a)	400	1000	1250
Jun	690	720	900	1100	(a)	700	1450	1650
Jul	690	720	900	1100	(a)	850	1550	1800
Aug	690	720	900	1100	(a)	850	1550	1800
Sep	580	610	750	900	(a)	600	1350	1550
Oct	450	470	580	700	(a)	(a)	900	1150
Nov	300	320	380	470	(a)	(a)	300	600
Dec	250	270	320	400	(a)	(a)	300	400

(a) Flows augmented by Gathright will be adequate.

To establish the storage required for low-flow augmentation at Lynchburg and Richmond, the effects of the water quality control storage at Gathright were considered. Using the entire 60,700 acre feet of water quality storage at Gathright to meet the needs along the Jackson and James Rivers as they arise, it is estimated that suitable water quality can be maintained at Lynchburg and Richmond to about 1980. After 1980, it is evident that further augmentation of the natural streamflow and/or a higher degree of waste treatment at the source, will be required.

Studies were made to determine the reservoir storage required in addition to that of Gathright to satisfy the flow requirements with the probability that, on the average, one month in 20 years would have less than the required flow. The results thereof indicate that the required storage in year 2020 would be:

a. About 85,000 acre feet above Lynchburg, and

b. About 182,000 acre feet above Richmond.

This storage is somewhat greater than indicated in Appendix D, because allowance was made for the inherent inefficiencies in operation due to imperfect forecasts of runoff from the uncontrolled drainage areas and flow time of water released from the reservoirs to travel to points of need.

The benefit resulting from low-flow regulation has been taken as the cost of the cheapest means of achieving the objective water quality. With the minimum acceptable level of waste treatment being considered as removal of 85 percent of five-day BOD, the means evaluated were (1) waste treatment plants which would remove 90 and 95 percent of the 5-day BOD and (2) flow regulation by single purpose reservoir in combination with waste treatment plants which would remove 85, 90 and 95 percent of the five-day BOD. Costs of single purpose reservoirs for a range in size at all of the better sites upstream from Lynchburg were estimated by the Corps of Engineers. Cost of waste treatment plants and the evaluation of alternative water quality control facilities, as determined by the FWPCA, are reported in Appendix D. According to FWPCA, the cheapest way of meeting the water quality control needs with waste load as anticipated to year 2020 was found to be construction of a reservoir in 1980, and increasing the level of waste treatment at Richmond to 90 percent BOD removal in 1995. This single purpose alternative reservoir would have a usable capacity of 75,000 acre feet and be located on Catawba Creek at the Stone House site.

A review of alternative water quality control systems was made by the Corps of Engineers, taking into account the increased storage required to provide a given yield as described in a preceding paragraph. The cheapest alternative was found to be a reservoir constructed in 1980 with a capacity of 85,000 acre feet and increasing the level of treatment at Richmond to 90 percent removal of BOD in 1990. The equivalent average annual cost

of this system over a 100-year period, beginning in 1980, is as follows:

Reservoir constructed in 1980	\$425,000 per year
Advanced waste treatment plant constructed at Richmond in 1990 (Discounted)	\$138,000 per year
Total	\$563,000 per year

Power benefits were taken as equal to the cost of supplying the power by the alternative measures which would be used in the absence of the project. Power benefits, as estimated by the FPC and reported in Appendix B, are \$21.80 per year per kilowatt of dependable capacity and 2.5 mills per kilowatt hour of energy.

Recreational use of a reservoir is expected to provide significant benefits. There is a growing demand for outdoor water-based recreation in the Hipes Reservoir area far in excess of existing and planned facilities. Accordingly, the value of a major reservoir for recreation is determined by the water area and the amount of suitable land around the reservoir. In all projects considered, the cost estimate included the cost for land and facilities necessary to permit optimum development of the recreation potential appropriately discounted to the year 1980. The estimated value of recreation opportunity, which would be afforded by a reservoir, was furnished by BOR and the U.S. Fish and Wildlife Service.

Economic expansion benefits of two types, redevelopmental and developmental, would be provided by reservoirs in Sub-region C. Redevelopment benefits consist of direct wage payments made to persons employed in the construction, operation and maintenance of the project. Developmental benefits are measured in terms of wage payments made to persons not directly associated with the project, but whose employment results from the economic activity induced by the project. In Sub-region C user induced developmental benefits will stem principally from expenditures made by those using the recreation facilities provided by the project. The procedures used to estimate these benefits, as described in Section V of this chapter for Hipes Reservoir, were also applied for all other projects which were considered.

Costs for the dam, reservoir preparation, and recreation facilities used in the analysis of alternative plans of development were taken from curves developed from preliminary layouts, estimates of quantities, and current unit prices. Real estate costs were based on field inspection of the property and investigation of recent sales of property in the area. The total acquisition cost includes resettlement, severance damage, contingencies, and personnel costs. Powerhouse and switchyard costs for projects with conventional units were taken from curves indicating

cost per kilowatt as a function of head and unit size. These cost curves were prepared by the FPC on the basis of existing Corps of Engineers, Tennessee Valley Authority, and municipal plants in the southeast. For pumped storage installations, cost of powerhouse and switchyard was taken as 12-1/2 percent higher than for conventional plants.

Annual charges on the total investment were based on an interest rate of 3-1/4 percent and amortization in 100 years. Annual operation and maintenance charges were based on experience at similar Corps of Engineers' projects in recent years plus the specific costs for recreation. Operation and maintenance charges for recreation were developed from District estimates of personnel and equipment required to provide adequate services to the visiting public. The annual cost of major replacements was based on the present worth of the replaced items at 3-1/4 percent interest.

The economic cost of land and improvements has been taken as 5 percent of its market value, the difference between this cost and the portion included as interest being shown as land productivity loss in the economic analyses. Other types of income which would accrue from the reservoir area in the absence of the project have been deducted from expansion benefits for the project.

Alternate Reservoirs. Screening of alternatives is the process of preliminary selection and evaluation of projects to fulfill given needs. Reservoir sites were selected in the preliminary phase from map studies and from available data for sites considered in detailed engineering studies of the James River Watershed during the past 40 years. As a result, a total of 28 reservoirs located upstream from Lynchburg were investigated. Subsequently, field visits were made by engineers and geologists. This reconnaissance provided up-to-date information on possible engineering and geological problems which would be encountered, cultural development in the reservoir areas, and general attributes of the sites. Storage capabilities were developed in engineering studies, along with the relationships between storage capacity and structure size, and preliminary cost information. Those sites having obvious defects, such as unsuitable geologic conditions, excessive costs of relocations, and extremely poor cost to storage relationships, were eliminated from further consideration. In this manner, 28 sites were analyzed and compared. These sites, together with the most significant reason for rejection in this preliminary stage of analysis, are listed in Table 4-4.

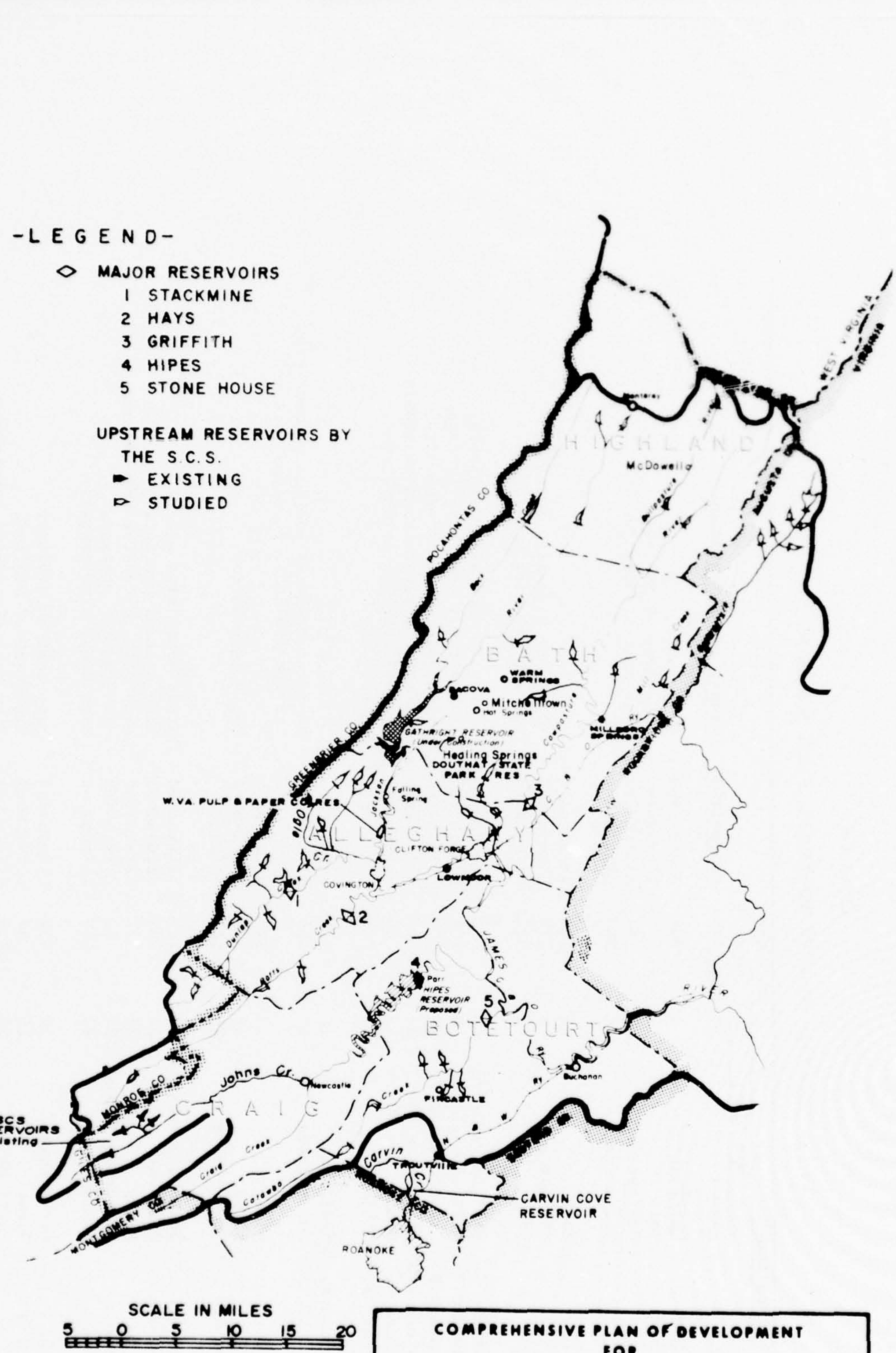
Five reservoir sites were retained for further study as a result of this initial screening. These sites were (a) Stackmine on Dunlap Creek, (b) Hays on Potts Creek, (c) Griffith on Cowpasture River, (d) Hipes on Craig Creek, and (e) Stone House on Catawba Creek. Their locations are shown on Exhibit 4-3.

Data on these five sites were developed in greater detail. Some field surveys and borings were required. Preliminary designs and cost

TABLE 4-4

ANALYSIS OF MAJOR RESERVOIRS, FIRST SCREENING

Location			Drainage Area		
	Dam Site				
Stream	Name	No.	sq.mi.	Disposition	Reason for Elimination
Jackson R.	Gathright	1	344	Under const.	
Ogle Cr.	Ogle	2	34	Eliminated	High cost of storage.
Ogle Cr.	Callaghan	3	44	Eliminated	High cost of storage.
Dunlap Cr.	Stackmine	4	103	Retained	
Potts Cr.	Hays	5	163	Retained	
Potts Cr.	Covington	6	170	Eliminated	Alternate Hays site better.
Jackson R.	King	7	812	Eliminated	Storage capacity small.
Bullpasture R.	Williamsville #3	8	92	Eliminated	Sinkholes and cavernous limestone in reservoir area make leakage probable. No local need for storage. Large storage available at Griffith site at moderate cost.
Bullpasture R.	Williamsville #2	9	104	Eliminated	
Bullpasture R.	Williamsville #1	10	108	Eliminated	
Cowpasture R.	Meadow Run #1	11	66	Eliminated	
Cowpasture R.	Meadow Run #2	12	66	Eliminated	
Cowpasture R.	McClung	13	218	Eliminated	
Cowpasture R.	Griffith	14	376	Retained	
Johns Cr.	Johns Creek	15	101	Eliminated	No local need for storage - Lower cost storage available at Hipes site.
Craig Cr.	Hipes	16	327	Retained	
Craig Cr.	Horton	17	333	Eliminated	Hipes site better.
Catawba Cr.	Stone House	18	114	Retained	
Catawba Cr.	Salisbury Furnace	19	115	Eliminated	Stone House site better.
Calfpasture R.	Whitesal	20	138	Eliminated	High cost of storage.
Maury R.	Maury	21	322	Eliminated	High cost. Extensive relocations.
Hays Cr.	Rockbridge Baths	22	82	Eliminated	High cost of storage.
Maury R.	Lexington	23	449	Eliminated	Kerr Creek site better.
Maury R.	Kerr Creek	24	450	Eliminated	High cost of storage.
Buffalo Cr.	Murat	25	80	Eliminated	High cost of storage.
James R.	Eagle Rock	26	1,830	Eliminated	High cost. Extensive relocations.
James R.	Lyle	27	1,980	Eliminated	Storage capacity small.
James R.	Varney Falls	28	2,150	Eliminated	Storage capacity small.



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

MAJOR RESERVOIRS
STUDIED IN DETAIL

Exhibit 4-3

estimates were made for three sizes of development. A preliminary evaluation was also made of the amount of water resource goods and services provided and the value thereof. Each of these sites would provide for the control of floods and for low-water regulation for water quality control, primarily along the James River downstream from Sub-region C. Each of the sites would also provide water-based recreation and expansion benefits. While power, either conventional or pumped storage, could be installed in any of the five sites, the most favorable location was thought to be at the Hipes site. A detailed study of the possibility of including power there was investigated and found not to be feasible at the present time. For this reason power was not considered at the other four sites. The example power studies are displayed in detail at the end of this paragraph.

At each site, detailed analyses were made for three heights of dam in order to determine the scale of the project that would provide maximum net annual benefits. Each alternative reservoir considered provided three watershed inches of storage for flood control and storage for water quality control. Each reservoir also provided inactive storage not less than the volume of sediment expected to be deposited in the reservoir in 100 years. The storage for water quality control was taken as the least amount consistent with the following criteria:

a. Drawdown not more than 30 feet.

b. Storage not more than 750 ac. ft. per sq. mi. of drainage area.

The 30-foot limit on drawdown was adopted so that maximization of the sum of recreation and water quality benefits would be approximated. The upper limit of storage for low-flow regulation of 750 acre feet per square mile was adopted to insure that the storage would be refilled in a reasonable period of time following drawdown and be available for reliable use in subsequent dry periods. The recreation benefits used in the analyses are based on a moderate drawdown and are considered to be sufficiently accurate for an evaluation of the relative merits of reservoirs at alternate sites.

Table 4-5 shows the results of this analysis for each of the five reservoirs that were studied in detail. It presents physical and economic data for the scale of development providing the maximum net benefits for each project, assuming the other four are not constructed. In each instance, it was assumed that construction of Gathright was complete. The evaluation of annual charges and benefits differs from that described in the preceding text, and used in subsequent project formulation studies, as follows:

a. Land productivity loss has been based on cost of land only rather than cost of land and improvements.

b. Other types of income which would accrue from the reservoir area in the absence of the projects have not been deducted from project expansion benefits.

TABLE 4-5

SUMMARY OF PRELIMINARY ECONOMIC ANALYSES OF MAJOR RESERVOIRS

	Stackmine	Hays	Griffith	Hipes	Stone House
PHYSICAL DATA					
Location: Stream	Dunlap Creek	Potts Creek	Cowpasture R.	Craig Creek	Catawba Creek
Dam, river mile	17.9	5.6	13.7	14.8	3.6
Drainage area, square miles	103	163	376	327	111
Type of dam	Earth	Concrete	Earth	Earth	Concrete-Earth
Type of spillway	Gated	Gated	Gated	Gated	Gated
Maximum height of dam, feet	170	174	182	170	128
Reservoir elevation, feet above msl					
Top of dam	1630	1420	1310	1185	1108
Top of spillway gate	1620	1410	1300	1175	1098
Maximum conservation pool	1608	1394	1288	1165	1095
Minimum conservation pool	1578	1364	1258	1135	1074
Storage capacity, acre feet/watershed inches					
To top of spillway gate	82,500/15.0	122,000/14.0	380,000/19.0	305,000/17.5	220,000/37.2
Flood control	16,500/ 3.0	26,000/ 3.0	60,000/ 3.0	52,000/ 3.0	18,000/ 3.0
Conservation (a)	29,000/ 5.3	46,000/ 5.3	130,000/ 6.5	121,000/ 6.9	85,000/14.4
Sediment and inactive	27,000/ 6.7	50,000/ 5.7	190,000/ 9.5	132,000/ 7.6	117,000/19.8
Reservoir surface area, acres					
At maximum conservation pool	1180	1650	5000	4770	4670
At minimum conservation pool	810	1200	3600	3400	3400
ECONOMIC DATA					
Construction cost and investment					
Dam and appurtenances	$10,650,000	$12,700,000	$15,600,000	$12,320,000	$ 7,400,000
Land and damage	1,165,000	1,900,000	2,550,000	2,210,000	3,360,000
Relocations and clearing	2,300,000	6,190,000	10,360,000	2,615,000	6,190,000
Recreation facilities (b)	875,000	1,740,000	3,050,000	4,090,000	5,080,000
Total	14,990,000	22,530,000	31,560,000	21,235,000	22,030,000
Interest during construction	970,000	1,460,000	2,050,000	1,380,000	1,432,000
Total investment	15,960,000	23,990,000	33,610,000	22,615,000	23,462,000
Average Annual Charges					
Interest, 3-1/4%	519,000	780,000	1,090,000	735,000	763,000
Amortization in 100 years	22,000	33,000	47,000	31,000	32,000
Operation and maintenance	121,000	154,000	215,000	272,000	301,000
Major replacement	26,000	27,000	33,000	44,000	51,000
Land productivity loss	7,000	8,000	39,000	21,000	27,000
Total	695,000	1,002,000	1,414,000	1,103,000	1,174,000
Average Annual Benefits					
User benefits					
Flood control	50,000	80,000	130,000	130,000	45,000
Water quality control	142,000	[illegible]	510,000	498,000	425,000
Recreation	164,000	252,000	543,000	1,015,000	1,130,000
Total	356,000	562,000	1,183,000	1,643,000	1,600,000
Expansion benefits, national					
Development	8,000	10,000	20,000	57,000	35,000
Redevelopment	148,000	217,000	296,000	235,000	254,000
Total	156,000	227,000	316,000	292,000	289,000
Expansion benefits, national plus regional					
Development	60,000	100,000	200,000	404,000	520,000
Redevelopment	368,000	517,000	759,000	684,000	745,000
Total	428,000	617,000	959,000	1,088,000	1,265,000
Total benefits					
User	356,000	562,000	1,183,000	1,643,000	1,600,000
National	512,000	789,000	1,499,000	1,935,000	1,889,000
National plus regional	784,000	1,179,000	2,142,000	2,731,000	2,865,000
Net benefits					
User	-339,000	-440,000	-231,000	540,000	426,000
National	-183,000	-213,000	85,000	832,000	715,000
National plus regional	89,000	177,000	728,000	1,628,000	1,691,000

(a) Limited to 750 acre feet per square mile of drainage area or that provided by 30-foot drawdown, whichever is least.
(b) Initial facilities plus present worth of future facilities.

c. The national redevelopment benefits indicate amounts which should be transferred to the national development benefit category.

These differences have not been eliminated because they are too minor to influence the site selection decision.

This table clearly indicates that the average annual net benefits for projects at the Stackmine, Hays, and Griffith sites are relatively small. Accordingly, these projects were eliminated from further consideration as the first-priority project.

The net annual user and national benefits of Hipes would be greater than for Stone House but the net national plus regional benefits would be $63,000 less. This difference is about two percent of the total benefits of each project, hardly a significant quantity. Also, there are the following additional differences which are not reflected in the comparison of net benefits:

a. The cost of constructing Hipes project would be less than the cost of constructing the Stone House project and it would control 327 square miles of drainage area as compared to 111 square miles at Stone House. Control of a larger drainage area would provide greater control of flood flows and yield more for the maintenance of low flows.

b. At Hipes the subsurface exploration has been fairly extensive. This damsite is located in an area of stable, uniform, tight shales having great thickness and no tendency to solution. The Stone House damsite is situated on limestone of a potentially soluble nature, as evidenced by the numerous sink holes and caverns nearby. There has been no subsurface exploration to check the solubility, the jointing, clay-filled seams or the geological attitude of the rocks. The reservoir itself would be underlain by soluble limestones and no investigations to check present or potential future leakage have been made. Therefore, there is greater assurance that a trouble-free project could be constructed at the estimated cost at the Hipes site than at the Stone House site.

c. The amount of land suitable for agricultural use in Hipes Reservoir area is less than in Stone House Reservoir area. While this situation is reflected in the estimate of cost, the disruptive effect on the local economy of removing more acres of arable land, in an area where such land is scarce, is not reflected in the analysis.

d. The presence of extensive National Forest areas immediately adjacent to the Hipes Reservoir would give it a great potential for future development, such as the development of a large park, either state or national. There are no extensive wild areas adjacent to the Stone House Reservoir site.

These analyses clearly indicated that a multiple purpose reservoir at the Hipes site was the most feasible solution of the needs for water control in the upper James River Basin in Water Sub-region C. Subsequent studies were therefore limited to the determination of the optimum development of the proposed Hipes Reservoir project.

Example Hydropower Studies - Hipes Reservoir - Formulation studies for projects without power revealed that net benefits would be maximized if Hipes Dam were constructed to the maximum height permitted by the topography. Inclusion of power generating facilities was therefore considered only in conjunction with projects that would develop the full potential of the site. Specifically, all alternative projects considered would have a maximum conservation pool at elevation 1160 and a full flood pool at elevation 1175.

The storage allotted to flood control and flood control operation would be the same as for projects without power. When flood stages occur along the upper James River, releases from Hipes, including discharge of any turbines considered, would be reduced until the peak has passed the mouth of Craig Creek. However, for purposes of this study, the dependable capacity of the project has not been discounted because of this operation.

Since evacuation of the flood pool may be at a higher rate than can be utilized through the turbines or at times when there would be no power demand, a reduction of 10 percent has been applied to the average annual stream flow when estimating the average annual generation of conventional units. When pumped storage developments were evaluated, this loss was reduced to 5 percent because much larger installations were considered.

In all plans that included power, consideration was given to any water quality control benefits that would accrue incidental to the generation of power. For pumped storage developments the water quality benefits would not be affected since water would be released downstream in the same amount as from a project without power.

Use of the recreation facilities of the project would provide significant benefits. In all projects considered, land and facilities would be provided as necessary to permit optimum development of the recreation potential. These costs and benefits are reflected in the economic analysis. Recreation benefits of the project would be reduced by the addition of power production as a project purpose because water levels in the reservoir would be less favorable. With conventional units seasonal drawdown would be greater. With pumped storage the water level would fluctuate more and be lower due to the daily and weekly cycle of the generating-pump operation. However, for this analysis no distinction in recreation benefits was made between projects with or without power.

No redevelopment benefit was claimed for the manufacture of the powerhouse and switchyard equipment, since this would be produced outside the local area and by craftsmen who are not normally underemployed. The cost of this equipment was taken as 50 percent of the total powerhouse and switchyard costs. No wages paid to workers for operation and maintenance of the powerhouse were considered as a benefit to the national economy since these workers would normally enjoy full employment. All wages, however, were shown as a benefit to the regional economy.

Certain data and assumptions for hydropower analyses follow:

a. Streamflow. The U. S. Geological Survey has operated a gage about 3 miles downstream from the Hipes Damsite since 1925. The drainage area at the damsite and gage are 327 and 331 square miles, respectively. Streamflow for the period of record is shown by months on Exhibit 4-4. A storage-draft curve is shown on Exhibit 4-5.

b. Water losses. The allowance made for increased evaporation due to the impoundment was taken as a constant loss of 1 cfs/1,000 acres of lake surface. Leakage was taken as 0.3 percent of the turbine water capacity plus 2 cfs for the dam and dikes.

c. Off-peak release. The average off-peak release for conventional developments without a reregulating dam was assumed to be equal to the minimum monthly natural flow of record. For pumped storage developments with a reregulating dam, no off-peak release would be required because water would be released from storage in the reregulating reservoir during periods when no power was being generated at Hipes.

d. Area and capacity. Area and capacity curves for the Hipes Reservoir are shown on Exhibit 4-6.

e. Tailwater elevation. A tailwater rating curve at the Hipes damsite is shown on Exhibit 4-7.

f. Head loss. The total hydraulic losses from forebay to tailrace has been taken as 2 feet and 6 feet for conventional and pumped storage developments, respectively.

g. Efficiency. For conventional developments, dependable capacity was based on an average station efficiency of 83 percent during the critical period. For pumped storage developments, an average station efficiency of 83 percent was assumed when Hipes was drawn to minimum conservation pool. Average annual generation from streamflow was based on an average station efficiency of 85 percent in all cases.

h. Installed capacity. Criteria applied in selection of turbines for conventional developments were (1) design head equal to average critical period head, and (2) output at full-gate at minimum head equal

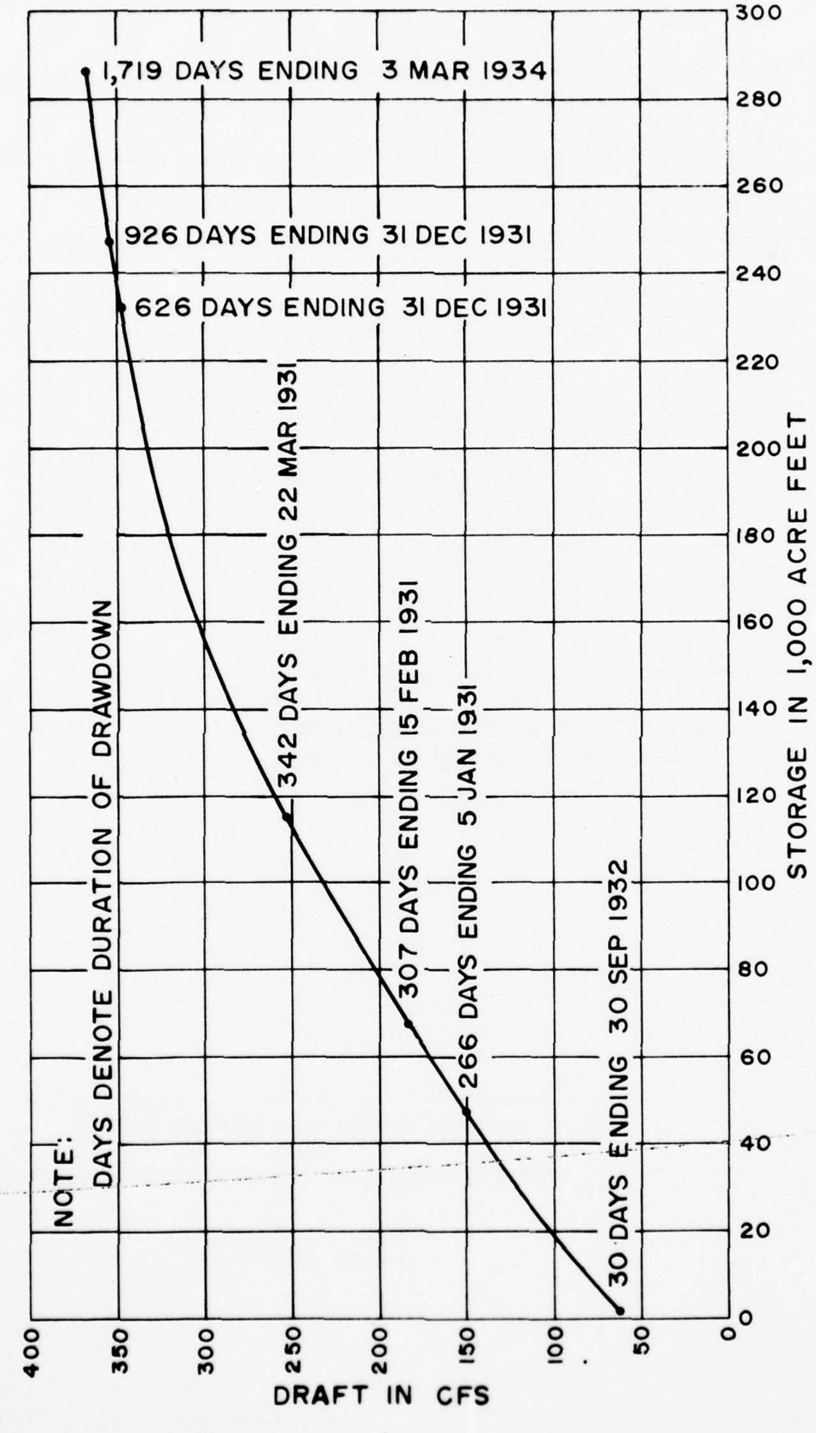
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1926	522	837	500	505	144	66	65	97	52	85	483	1100	369
1927	314	1470	349	1100	262	154	204	288	91	232	337	814	460
1928	599	420	431	619	426	177	130	974	974	150	104	129	427
1929	295	685	1020	647	652	579	159	61	55	728	778	383	502
1930	262	486	307	286	93	67	38	37	36	35	46	62	144
1931	174	146	305	694	482	217	156	356	69	45	48	109	234
1932	514	654	762	640	604	116	52	43	34	454	623	672	430
1933	566	731	691	976	543	183	80	58	41	40	47	70	332
1934	67	56	1355	681	124	78	92	100	206	332	580	706	367
1935	1337	508	1095	1382	214	108	91	68	476	72	216	417	498
1936	1532	983	1440	776	258	79	52	58	57	359	90	495	515
1937	1642	629	302	474	362	112	76	331	305	1093	370	286	499
1938	486	266	445	365	390	658	839	700	80	66	86	134	378
1939	480	1197	625	194	132	105	123	223	61	50	59	59	270
1940	90	472	262	951	936	568	116	1290	216	67	69	187	437
1941	294	181	321	366	120	188	979	64	67	42	52	140	236
1942	156	294	415	181	1202	711	104	467	156	302	305	728	420
1943	512	750	746	712	593	212	272	81	48	51	67	73	341
1944	197	617	949	383	388	116	46	37	56	149	77	239	271
1945	530	621	598	318	310	138	52	48	313	68	180	354	292
1946	875	707	565	374	647	108	111	45	40	58	64	93	306
1947	927	189	706	491	260	101	76	179	105	543	793	207	383
1948	205	1056	829	896	637	284	141	429	89	165	692	1519	577
1949	904	682	535	1073	707	273	658	309	231	167	489	408	535
1950	298	776	368	222	1007	394	170	112	218	94	122	730	374
1951	186	802	1076	1225	267	570	105	60	55	52	80	288	393
1952	870	809	1101	622	492	108	67	141	199	66	196	415	423
1953	592	935	1223	445	434	126	58	47	43	41	51	98	338
1954	299	244	831	393	305	96	119	64	45	207	178	600	283
1955	311	865	1922	471	144	95	68	133	55	47	55	53	349
1956	51	549	578	690	180	113	69	42	61	166	288	261	252
1957	603	1239	656	1095	202	180	55	41	564	261	545	602	496
1958	654	617	985	1270	986	137	155	146	56	53	60	147	438
1959	244	186	428	998	192	112	45	63	82	476	442	611	323
1960	402	1028	1073	914	554	186	55	45	55	45	51	55	369
1961	101	663	691	738	488	238	77	216	78	201	342	903	393
1962	593	691	1109	663	212	246	94	163	57	65	520	375	397
1963	745	232	1412	180	138	87	50	41	40	41	66	85	262
1964	641	593	912	680	160	87	44	36	46	91	151	256	307
1965	680	809	907	464	307	98	64	43	40	86	55	49	297
AVG	519	642	771	654	414	207	150	193	139	184	247	373	373
MAX	1642	1470	1922	1382	1202	711	979	1290	974	1093	793	1519	577
MIN	51	56	262	180	93	66	38	36	34	35	46	49	144

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

MEAN MONTHLY FLOWS
CRAIG CREEK AT PARR, VA.

SCALE
NONE

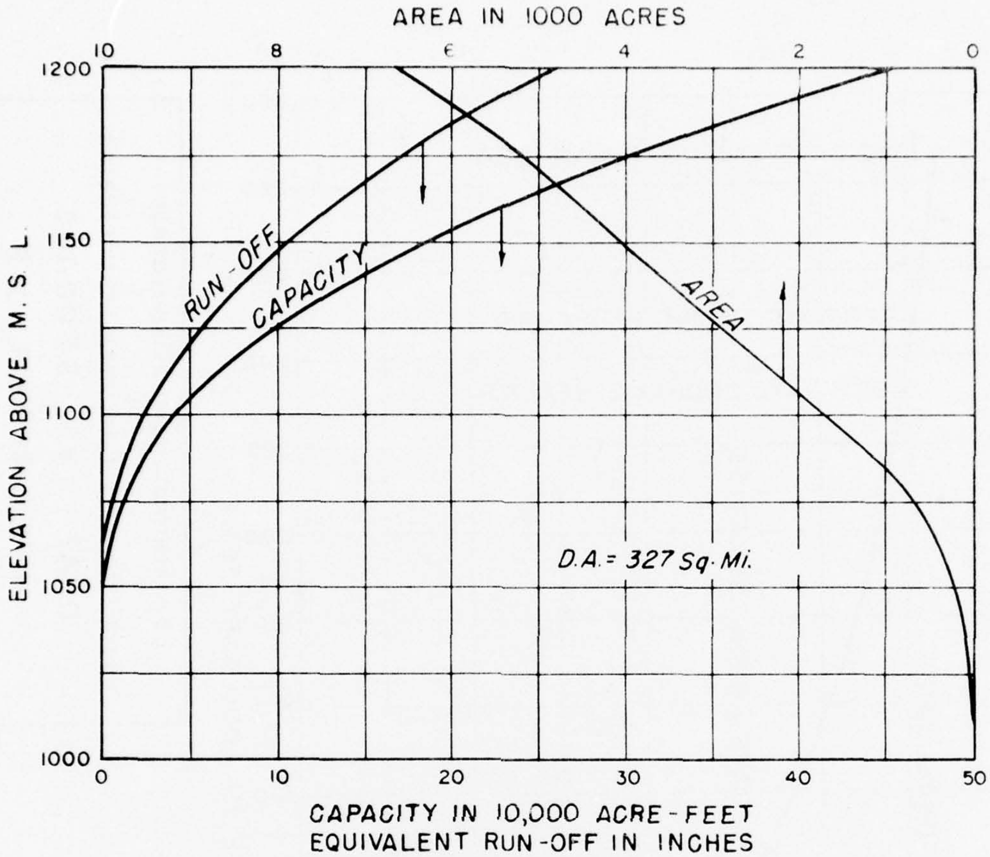
Drawn by: H J H
Checked by: R L N
Date: JANUARY 1968



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

DRAFT VS. STORAGE

HIPES RESERVOIR



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

AREA AND CAPACITY
HIPES RESERVOIR

SCALE
AS SHOWN

Drawn by: H.J.H.
Checked by: C.D.M.
Date: JANUARY 1968

Exhibit 4-6

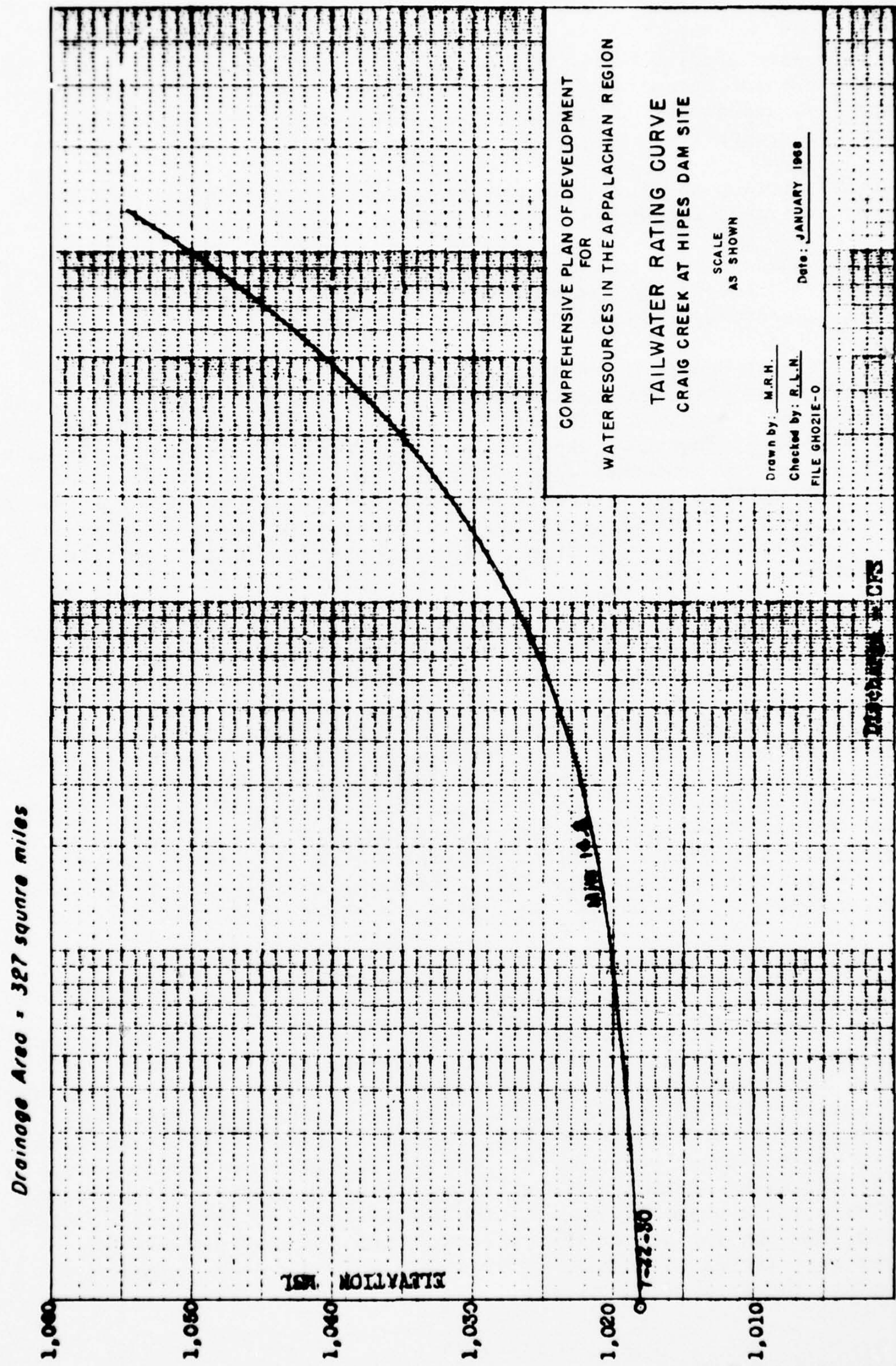

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
TAILWATER RATING CURVE
CRAIG CREEK AT HIPES DAM SITE
SCALE
AS SHOWN
Drawn by: M.R.H.
Checked by: R.L.N.
FILE GH021E-0
Date: JANUARY 1968
Drainage Area = 327 square miles
ELEVATION MSL
1,060
1,050
1,040
1,030
1,020
1,010
100
1,000
10,000
100,000

Exhibit 4-7

to best-gate turbine output at design head. For pumped storage developments, turbine output at full-gate at minimum head equal to dependable capacity, and installed capacity of the generators was equal to the dependable capacity.

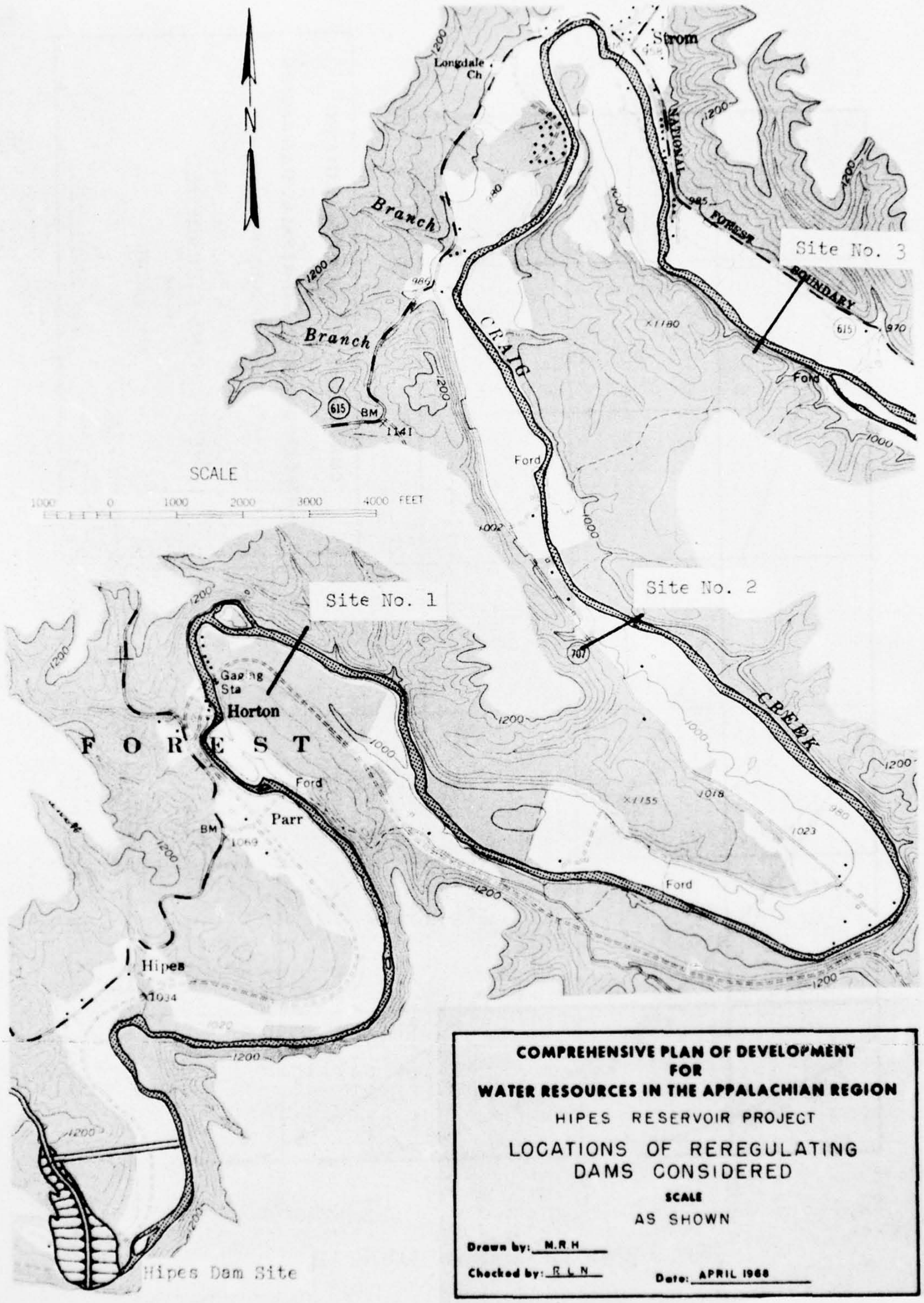
i. Station service. All energy generated at Hipes was considered to be available for support of the load.

j. Load factor. For conventional power developments, the critical period load factor was taken as 10 percent. For pumped storage developments, the average annual load factor was taken as 10 percent.

k. Power benefits and alternate costs. The values for benefits and alternate costs were estimated by the Federal Power Commission, and reported in Appendix B. The at-site power benefits were taken as $21.80 per year per kilowatt of dependable capacity and 2.5 mills per kilowatt-hour for energy produced. The alternate cost of power was taken as $11.35 per year per kilowatt of dependable capacity and 2.5 mills per kilowatt-hour of energy. This cost is based on the cost of power produced at a steam-electric plant with financing comparable to that of the hydroelectric power.

l. Reregulating dam. With conventional developments, the storage provided by the reregulating dam was that required to supply flow at the prime flow rate with the turbine shutdown for a 66-hour period. When the reregulating reservoir was used to provide afterbay storage for pumped storage developments, the storage volume between minimum power pool and the spillway crest was made equal to the release during a 6-hour generating period with the upper reservoir at minimum conservation pool elevation 1130. Minimum power pool elevation in the lower reservoir was made equal to the natural tailwater elevation corresponding to a discharge equal to the capacity of the pumps. Locations of the reregulating dams considered are shown on Exhibit 4-8 and capacity curves for each of the reservoirs are shown on Exhibit 4-9.

m. Layouts. A general layout of the project without power is shown on Exhibit 4-10. This plan includes an earthfill dam, a gated spillway in the left abutment, a control tower containing multiple level intakes, and a cut-and-cover conduit connecting the control tower and the stilling basin. This conduit will not flow full since it is sized for diversion purposes, and after construction, the discharge capacity will be limited by the upstream control gates. A general layout of the project with power is shown on Exhibit 4-11. This is the same as the plan without power except that the diversion and power tunnel is in the right abutment because a cut-and-cover conduit would not be suitable for a pressure conduit, the intake tower is designed to remove water from the surface of the reservoir, and the upstream control gates were increased in size to provide a waterway area approximately equal to the area of the tunnel.



COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

HIPES RESERVOIR PROJECT

LOCATIONS OF REREGULATING DAMS CONSIDERED

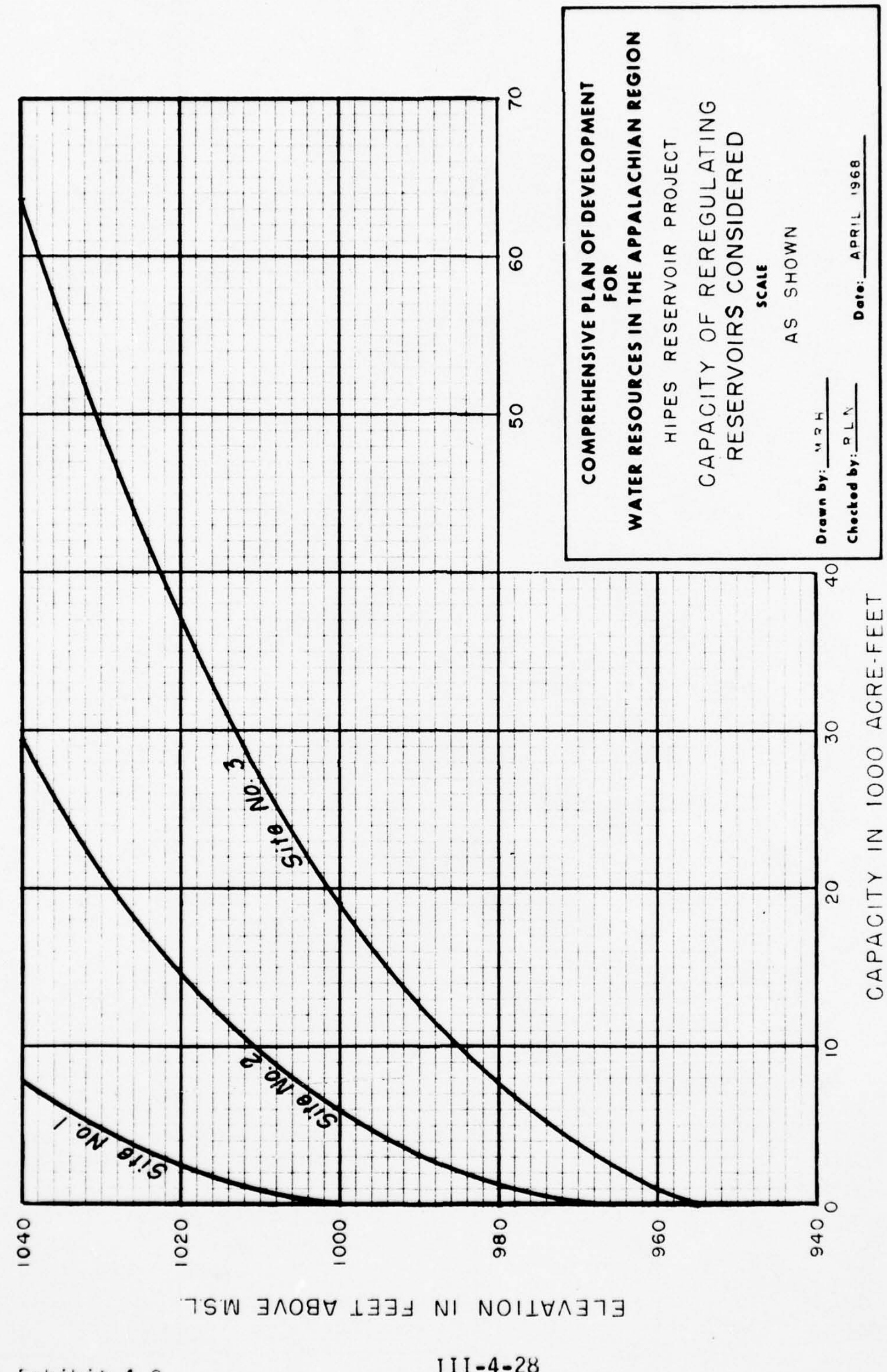
SCALE
AS SHOWN

Drawn by: M.R.H

Checked by: R.L.N. Date: APRIL 1968

FILE: GH032E-0

Exhibit 4-8


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
HIPES RESERVOIR PROJECT
CAPACITY OF REREGULATING
RESERVOIRS CONSIDERED
SCALE
AS SHOWN
Drawn by:
Checked by:
Date: APRIL 1968
Site No. 1
Site No. 2
Site No. 3
ELEVATION IN FEET ABOVE M.S.L.
1040
1020
1000
980
960
940
CAPACITY IN 1000 ACRE-FEET
0
10
20
30
40
50
60
70

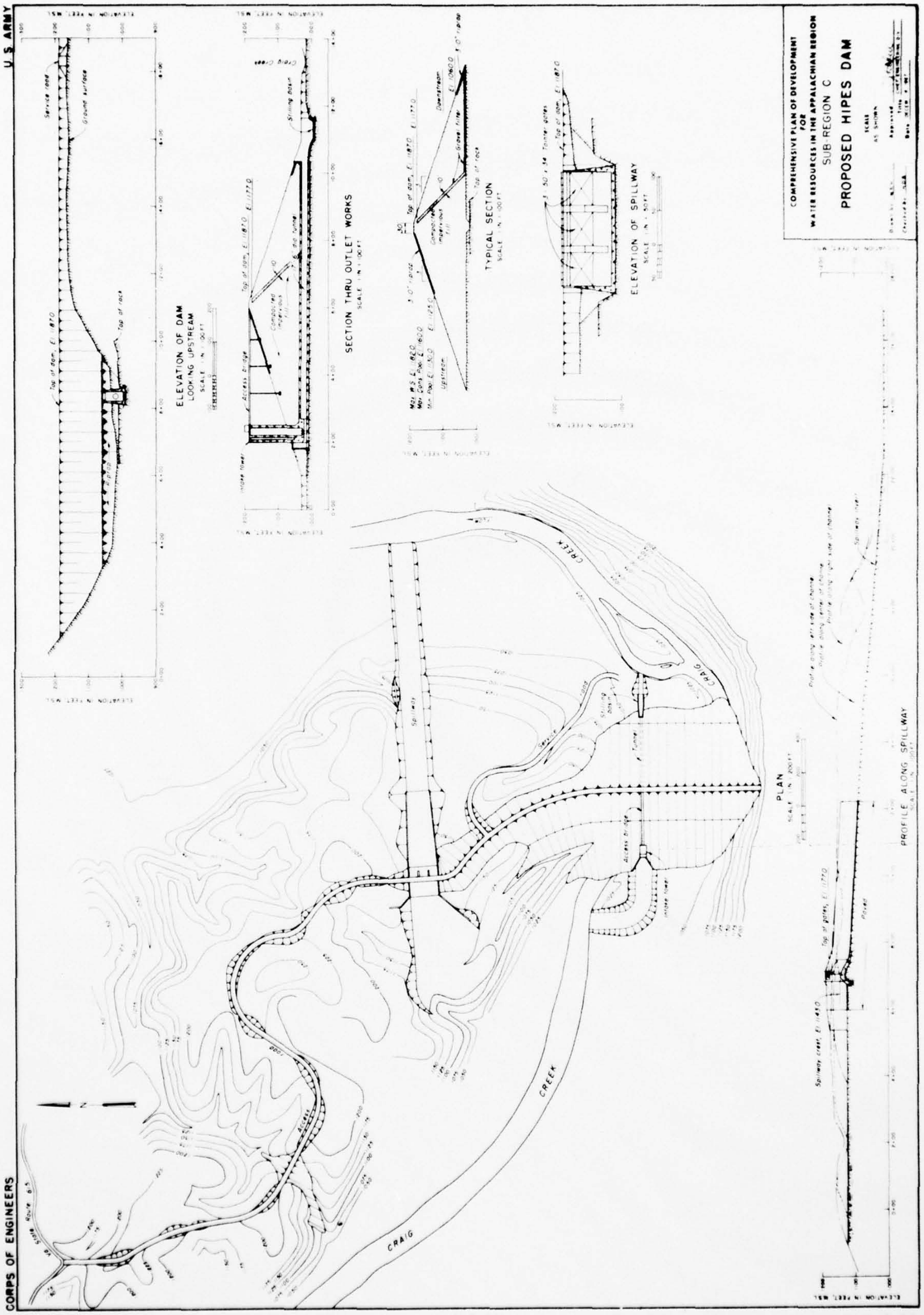

U.S. ARMY
CORPS OF ENGINEERS
COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION
SUB-REGION C
PROPOSED HIPES DAM
ELEVATION OF DAM
LOOKING UPSTREAM
SECTION THRU OUTLET WORKS
TYPICAL SECTION
ELEVATION OF SPILLWAY
PLAN
PROFILE ALONG SPILLWAY
CRAIG
CREEK
CRAIG
CREEK

Exhibit 4-10

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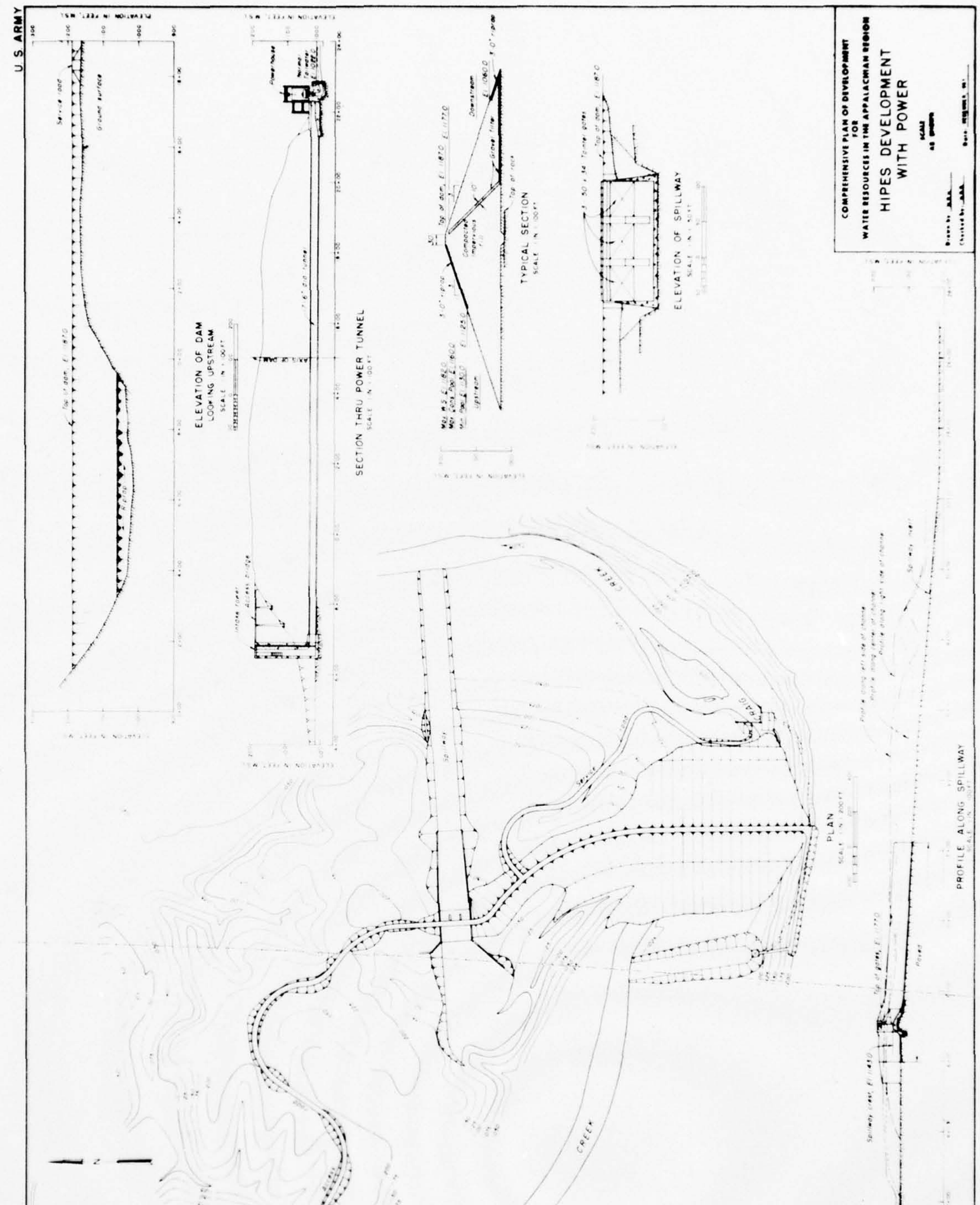

Exhibit 4-11

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Feasibility of Hydropower Installation - Two general plans of development with conventional power generating facilities were considered - one with a downstream reregulating dam and one without. For the plan without downstream reregulation, the average off-peak release was assumed to be equal to the minimum monthly natural flow of record. No water quality control benefits were claimed under this plan of operation, since only natural flow or less would be available during droughts for periods of 2 to 3 days on weekends. With downstream reregulation, it was assumed that no off-peak release would be required. The water quality control benefit for this plan of development was based on the assumption that minimum generation would be the same each week of the year. The project probably could be operated in a manner which would provide greater water quality control benefits without a loss of power benefits since it would supply only a small portion of the system load assigned to hydro. This possibility must be taken into account in using this analysis to determine the effect of power on the net benefits. Plans of development with integral type pumped storage power installations of 75,000 to 200,000 kilowatts were also investigated. Project physical data for each of the plans of development with and without power are presented in Table 4-6, and attendant costs and benefits are given in Tables 4-7a and 4-7b.

The installation of power facilities would not be justified because, in Plan 2, net benefits would be reduced and, in Plans 3 through 7, an equal amount of power could be produced at less cost at a steam-electric generating station as shown in items 4, 5 and 6 of Table 4-7a.

Modification of the proposed project to permit future installation of power generating facilities would result in a significant increase in project costs because:

a. The tunnel would require a steel lining.

b. Larger upstream control gates would be required.

c. It would be necessary to modify the tower design to permit larger releases of water from the surface.

In addition to the increased project costs, modification of the project to permit future installation of power generating facilities would also eliminate the development of a downstream trout fishery since the cost of a tower capable of selective withdrawal of such large releases of water would be prohibitive. If a future pumped storage development were contemplated, the proposed site of the trout rearing station would be inundated by the afterbay reservoir.

The development of conventional or integral type pumped storage power generating facilities initially or making provision for their future development is therefore not recommended. The Atlanta Regional Engineer of the Federal Power Commission agrees with this conclusion as stated in his letter which is included in Section IX of this chapter.

AD-A041 392 CORPS OF ENGINEERS CINCINNATI OHIO F/G 8/6
DEVELOPMENT OF WATER RESOURCES IN APPALACHIA. MAIN REPORT. PART--ETC(U)
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TABLE 4-6

PHYSICAL DATA, HIPES RESERVOIR WITH AND WITHOUT POWER

Feature	PLAN 1 (without power)	PLAN 2 (conventional power)	PLAN 3 (conventional power) (a)	PLAN 4 (pumped storage power) (a)	PLAN 5 (pumped storage power) (a)	PLAN 6 (pumped storage power) (a)	PLAN 7 (pumped storage power) (a)
HIPES RESERVOIR							
Location: Stream	Craig Creek	Craig Creek	Craig Creek	Craig Creek	Craig Creek	Craig Creek	Craig Creek
Dam, river mile	14.8	14.8	11.3	7.9	7.9	7.9	4.5
Powerhouse, river mile	-	14.8	14.8	14.8	14.8	14.8	14.8
Drainage area, sq. mi.	327	327	-	-	-	-	-
Type of dam	Earth	Earth	Conc. & Earth	Concrete	Concrete	Concrete	Conc. & Earth
Type of spillway	Gated	Gated	Ungated	Ungated	Ungated	Ungated	Ungated
Reservoir elevations, ft. above msl							
Top of dam	1187	1187					
Crest of ungated spillway or top of spillway gates	1177	1177	1015	1034	1038	1046	1043
Maximum power or conservation pool	1160	1160	1015	1034	1038	1046	1043
Minimum power or conservation pool	1130	1130	1004	1025	1027	1030	1032
Storage capacity, acre feet							
Top of flood pool	304,700	304,700	-	-	-	-	-
Flood control	73,300	73,300	-	-	-	-	-
Conservation or power	115,700	115,700	1,750	5,630	7,725	12,700	52,000
Sediment and inactive	115,700	115,700	600	18,800	20,000	22,000	16,500
Power data: Installed capacity, MW		18	20.5	75	100	150	200
Dependable capacity, MW		18	20.5	75	100	150	200
Average annual generation, MWH		24,000	26,700	65,700	87,600	131,400	175,200
Average annual load factor, percent		-	-	10	10	10	10
Average critical period load factor, percent		10	10	-	-	-	-

(a) Physical data shown are for reregulating dam, except powerhouse which is at Hipes. Other data for Hipes same as Plan 1.

TABLE 4-7a

ECONOMIC DATA, HIPES RESERVOIR WITH AND WITHOUT POWER

Item	PLAN 1 (without power)	PLAN 2 (conventional power)	PLAN 3 (conventional power)	PLAN 4 (pumped storage power)	PLAN 5 (pumped storage power)	PLAN 6 (pumped storage power)	PLAN 7 (pumped storage power)
COSTS							
1. Investment: Hipes Dam, Reservoir, powerhouse and switchyard	$23,822,000	$26,160,000	$26,479,000	$40,146,000	$46,163,000	$63,044,000	$76,303,000
Downstream trout fishery	332,000	0	0	0	0	0	0
Trout rearing station	751,000	909,000	909,000	0	0	0	0
Afterbay dam and reservoir	0	0	3,454,000	8,595,000	9,204,000	10,426,000	14,460,000
TOTAL	$24,905,000	$27,069,000	$30,842,000	$48,741,000	$55,367,000	$73,470,000	$90,763,000
2. Average annual charges	$ 1,199,000	$ 1,411,000	$ 1,551,000	$ 2,407,000	$ 2,761,000	$ 3,665,000	$ 4,524,000
3. Project w/o power							
Hipes Dam & Reservoir 1/	$ 1,081,000	$ 1,081,000	$ 1,081,000	$ 1,081,000	$ 1,081,000	$ 1,081,000	$ 1,081,000
Downstream fishery	18,000	0	0	0	0	0	0
Trout rearing station	100,000	100,000	100,000	0	0	0	0
TOTAL	$ 1,199,000	$ 1,181,000	$ 1,181,000	$ 1,081,000	$ 1,081,000	$ 1,081,000	$ 1,081,000
4. Separable cost of power	0	$ 230,000	$ 370,000	$ 1,326,000	$ 1,680,000	$ 2,584,000	$ 3,443,000
5. Alternate cost 2/	0	$ 264,000	$ 300,000	$ 1,016,000	$ 1,354,000	$ 2,031,000	$ 2,708,000
6. Net annual advantage of hydropower over thermal generation (item 5 - item 4)	-	$ 34,000	$ - 70,000	$ - 310,000	$ - 326,000	$ - 553,000	$ -735,000

1/ Annual charges same for all plans - Physical data shown for Plan 1 in table 4-6.

2/ Steam-electric generating facilities - Annual cost based on 2.5 mills per KWH of energy produced and $11.35 per kilowatt of dependable capacity. Example: Plan 2 - 18,000 KW @ $11.35 + 24,000,000 KWH @ $0.0025 = $264,300 - round to $264,000.

TABLE 4-7b

ECONOMIC DATA, HIPES RESERVOIR WITH AND WITHOUT POWER

Item	PLAN 1 (without power)	PLAN 2 (convention-al power)	PLAN 3 (convention-al power)	PLAN 4 (pumped storage power)	PLAN 5 (pumped storage power)	PLAN 6 (pumped storage power)	PLAN 7 (pumped storage power)
BENEFITS							
Average annual benefits							
User benefits							
Flood control	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000
Water quality control	490,000	0	300,000	490,000	490,000	490,000	490,000
Recreation: Reservoir	1,012,000	1,012,000	1,012,000	1,012,000	1,012,000	1,012,000	1,012,000
Downstream trout fishery	29,000	0	0	0	0	0	0
Trout rearing station	338,000	338,000	338,000	0	0	0	0
Power	0	452,000	514,000	1,799,000	2,399,000	3,599,000	4,798,000
Total	$1,999,000	$ 1,932,000	$ 2,294,000	$ 3,431,000	$ 4,031,000	$ 5,231,000	$ 6,430,000
Expansion benefits, National							
Redevelopmental	$ 128,000	$ 135,000	$ 152,000	$ 212,000	$ 236,000	$ 300,000	$ 360,000
Developmental	175,000	181,000	195,000	233,000	254,000	308,000	359,000
Total	$ 303,000	$ 316,000	$ 347,000	$ 445,000	$ 490,000	$ 608,000	$ 719,000
Expansion benefits, National plus regional							
Redevelopmental	$ 369,000	$ 448,000	$ 484,000	$ 670,000	$ 732,000	$ 903,000	$ 1,055,000
Developmental	773,000	835,000	865,000	960,000	1,014,000	1,158,000	1,288,000
Total	$ 1,142,000	$ 1,283,000	$ 1,349,000	$ 1,630,000	$ 1,174,000	$ 2,061,000	$ 2,343,000
Total benefits							
User	$ 1,999,000	$ 1,932,000	$ 2,294,000	$ 3,431,000	$ 4,031,000	$ 5,231,000	$ 6,430,000
National	2,303,000	2,248,000	2,641,000	3,876,000	4,521,000	5,839,000	7,149,000
Net benefits							
User	$ 800,000	$ 521,000	$ 743,000	$ 1,024,000	$ 1,270,000	$ 1,566,000	$ 1,906,000
National	1,103,000	837,000	1,090,000	1,469,000	1,760,000	2,174,000	2,625,000

7. HIPES RESERVOIR - DETAILED PROJECT FORMULATION STUDIES

In the initial formulation studies, analyses were made of various heights of dam at each site as stated in the preceding discussion. The results of these studies for Hipes indicated that net benefits increased with height of dam, as shown on Exhibit 4-12. The topography, however, limited the development to a full pool of about elevation 1175 msl. Accordingly, the development of Hipes was optimized by:

a. Increasing the flood control storage from 3 to 4.2 inches, in order to control a flood over the drainage area equal to 50 percent of the standard project flood. Reserving 4.2 inches of storage below the top of gates for the temporary retention of floodwaters results in a project having a maximum conservation pool elevation of 1160.

b. Determining the amount of reservoir storage to be used for low-flow regulation which would maximize net benefits. This analysis is required because the increase in water quality control benefits associated with an increase in use of storage for this purpose is accompanied by a decrease in recreation benefits due to greater drawdown of water level in the reservoir.

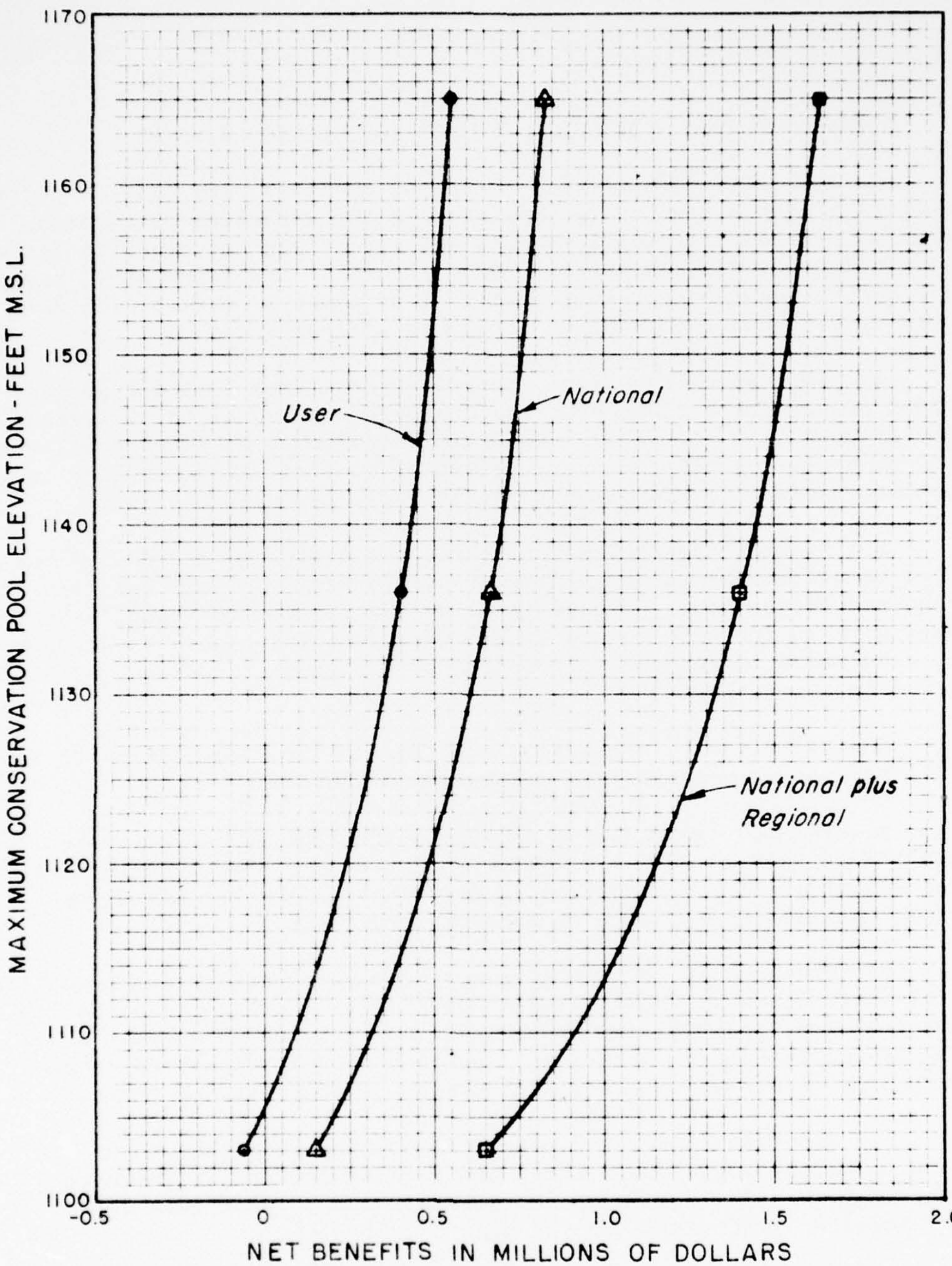
The relationship of storage used for low-flow regulation to water quality control benefits was determined as follows:

a. The storage required to supply the flow needed for water quality is shown on Exhibit 4-13. The procedure used to determine the amount of storage required is discussed in the preceding paragraph entitled "Evaluation of Benefits and Costs."

b. The benefit resulting from achieving objective water quality with waste loads as anticipated to year 1990 is estimated as $425,000 per year and $563,000 with waste loads as anticipated to year 2020. The procedure used to determine these benefits is discussed in the preceding paragraph entitled "Evaluation of Benefits and Costs."

c. The relationship of benefit resulting from the use of varying amounts of storage for water quality control is shown on Exhibit 4-14. The following coordinates used to plot this curve are based on information in "a" and "b" above.

Year	Storage required, acre-feet	Average Annual Benefit
1980	0	0
1990	85,000	$425,000
2020	182,000	$563,000

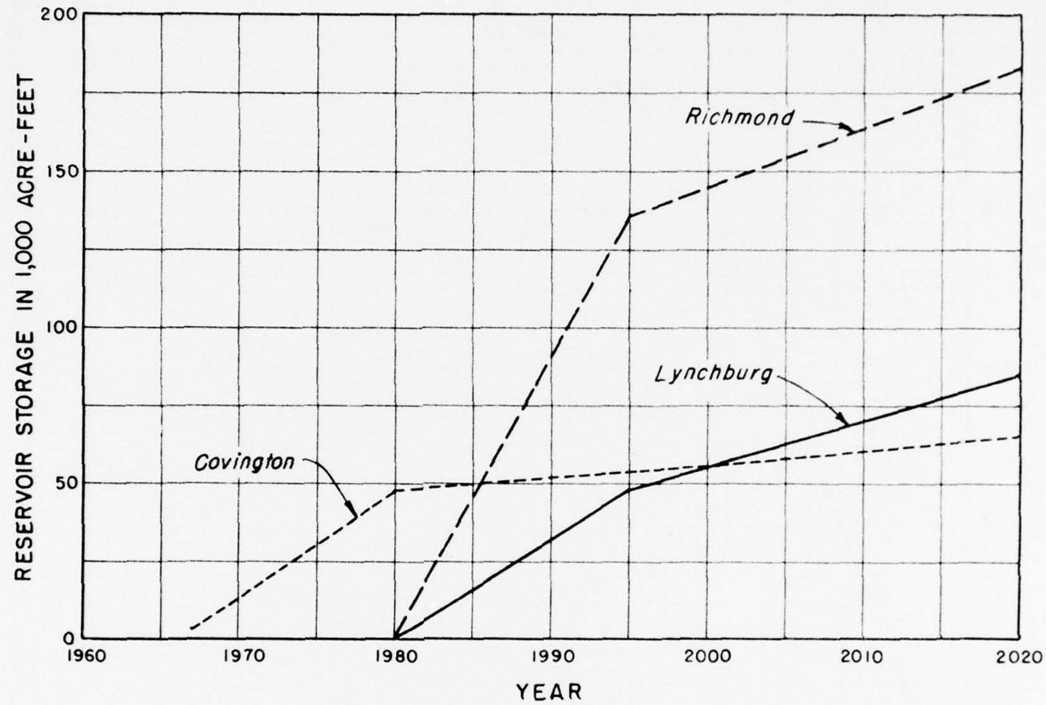


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CONSERVATION POOL VS NET BENEFITS

HIPES RESERVOIR

Exhibit 4-12



NOTE:

Storage required at Lynchburg and Richmond is in addition to the 60,700 acre-feet provided by Gathright Reservoir now under construction.

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

STORAGE REQUIRED FOR
WATER SUPPLY, AND WATER QUALITY
CONTROL WITH 85% B.O.D. REMOVAL
BY TREATMENT

HIPES RESERVOIR

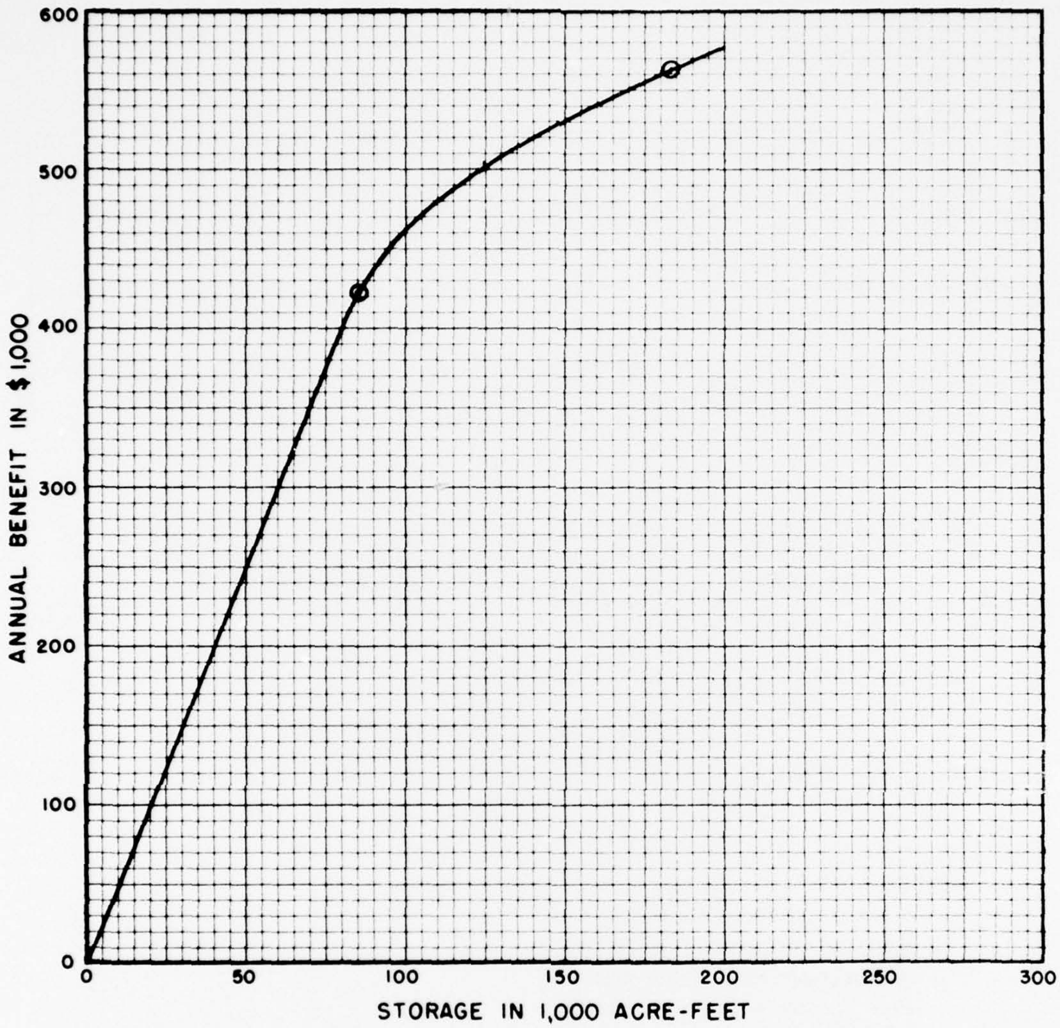
SCALE
AS SHOWN

Drawn by: H.J.H.

Checked by R.L.N.

Date: MARCH 1968

Exhibit 4-13



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

WATER QUALITY CONTROL BENEFIT
HIPES RESERVOIR

SCALE
AS SHOWN

Drawn by: R.H.B.
Checked by: R.L.H.
Date: APRIL 1968

Exhibit 4-14

The following procedure was used to determine the relationship of storage utilized for low-flow regulation to recreation benefits:

a. The reservoir was operated through the period of streamflow record, 1926 through 1965, to meet water quality flow requirements of varying magnitude to determine the resultant fluctuation of the water level in the reservoir. The reservoir elevations resulting from an operation which would limit the maximum drawdown to 30 feet are shown on Exhibits 4-15 and 4-16.

b. A relationship of drawdown to amount of recreational use and benefit per visitor day was estimated as described in Section V of this chapter.

c. Equivalent average annual recreational use equal to 711,000 visitor days when the drawdown is zero distributed by months as follows:

Jan	0	May	35,600	Sep	71,100
Feb	0	Jun	165,900	Oct	71,100
Mar	7,100	Jul	165,900	Nov	7,100
Apr	21,300	Aug	165,900	Dec	0

d. The general recreation benefit of the reservoir was computed by months using the relationship described in "a", "b" and "c" above and a benefit to fishermen added. The resultant relationship of equivalent average annual benefit to maximum drawdown is shown on Exhibit 4-17.

Evaluation of projects with various amounts of storage used for low-flow regulation indicated that a 30-foot drawdown would provide maximum net benefits. With a 30-foot drawdown, 115,700 acre feet of storage would be provided for low-flow regulation. This is 51 percent of capacity of the reservoir that could be used for this purpose. The project would meet the downstream needs to about year 1993, at which time additional storage or advanced waste treatment would be required for maintenance of satisfactory water quality. The water quality benefits would be about 80 percent of the maximum which could be provided by the reservoir. The recreation user benefits would be about 88 percent of those which could be provided by optimum use of the reservoir for this purpose.

Annual Attendance - Estimates of annual visits to the reservoir and its lakeside reacreation areas were developed for various conservation pools. These estimates were based upon the proposed recreation development and the extent of water surface. The total annual visitor days are based on the estimates furnished by the Bureau of Outdoor Recreation and the Bureau of Sport Fisheries and Wildlife. They are deemed reasonable on the basis of computations made by this office.

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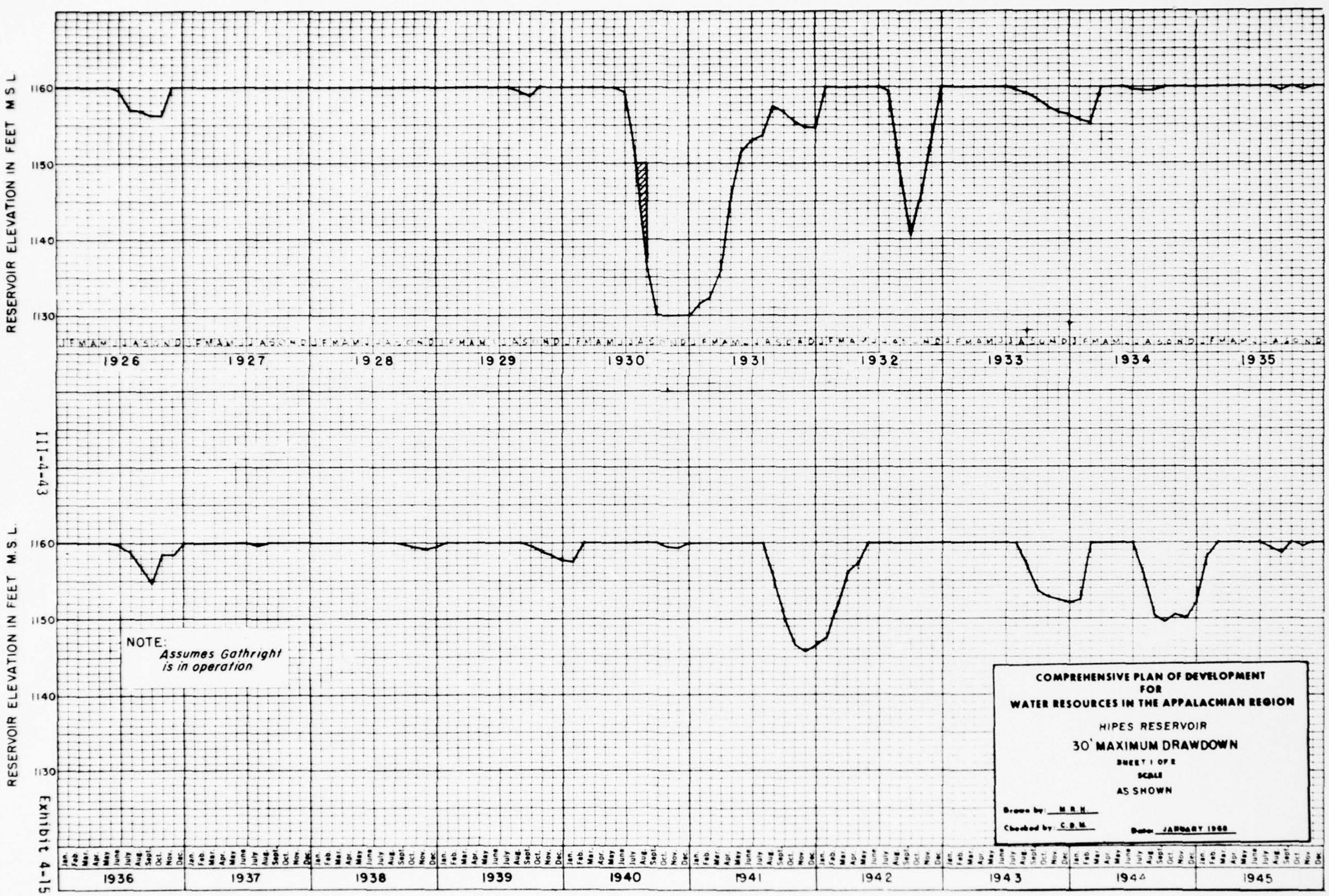

Exhibit 4-15

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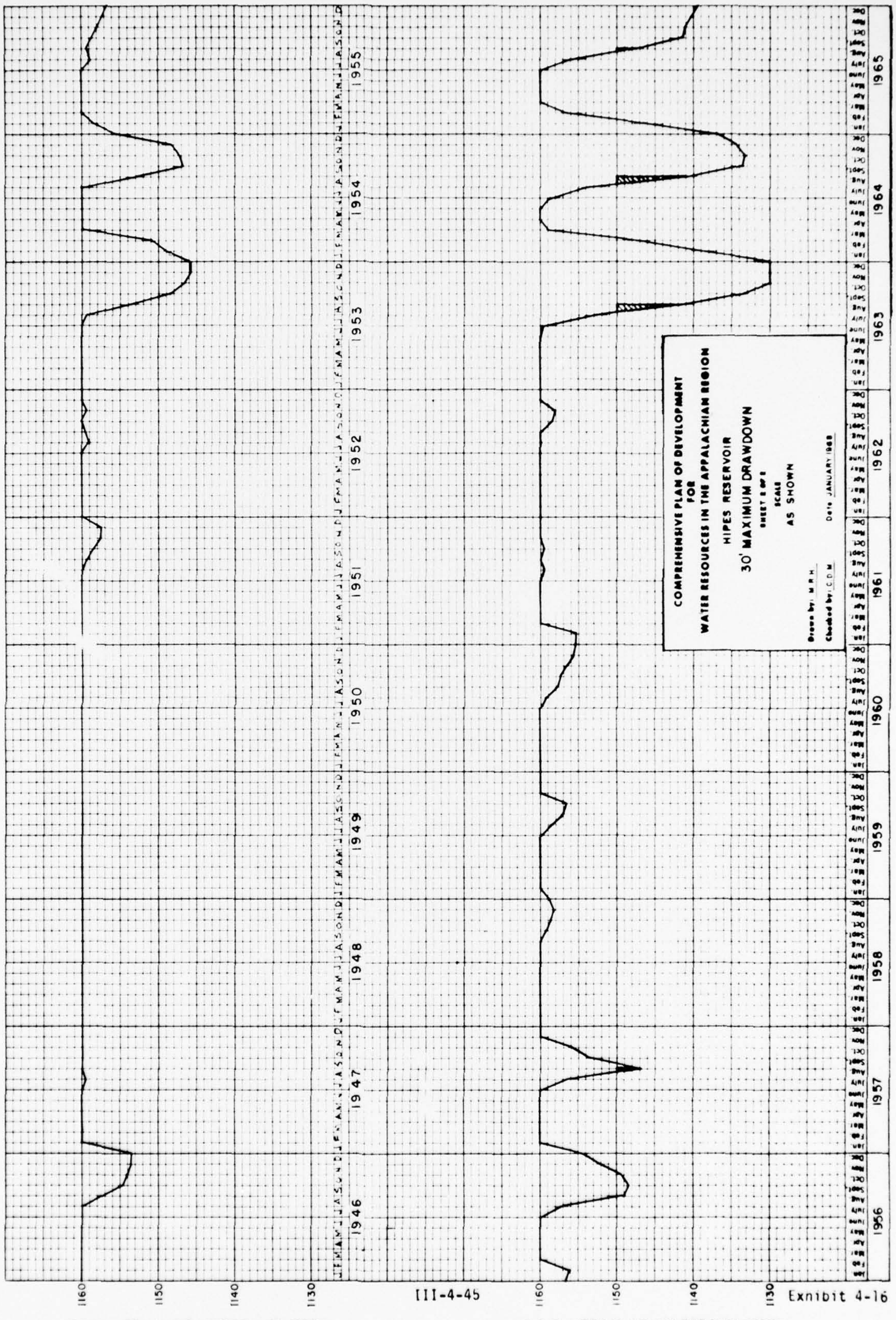

Exhibit 4-16

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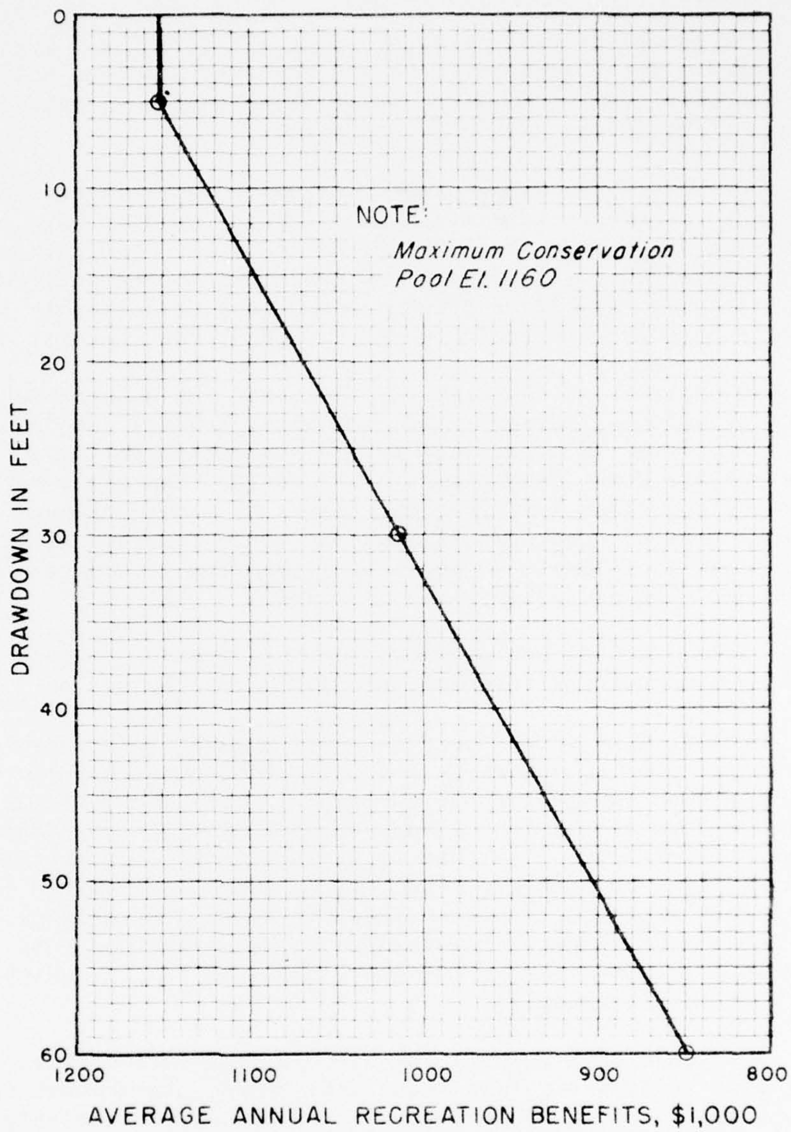


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

RECREATION BENEFITS
VERSUS DRAWDOWN
HIPES RESERVOIR

Exhibit 4-17

The annual attendance expected at the formulated project for general recreation was estimated to be 300,000 initially and 925,000 ultimately. In addition, the warm water fishing opportunity is expected to provide a net of 68,000 fisherman days annually.

Drawdown - The Hipes project operation will frequently result in drawdown of the conservation pool. Hence, studies were made to determine how significant the drawdown effect would be. Two methods of approach were evaluated: (1) drawdown by month based upon an accumulation of past records, and (2) a drawdown-frequency relationship for various levels of the conservation pool throughout the recreation season.

An analysis of the drawdown frequency for the proposed reservoir was made by hypothetical operation for water quality control, month by month, for the period of streamflow record, 1926 through 1965. The results thereof are shown on Exhibits 4-15 and 16. The cross-hatched area indicates the times a 10-foot or greater drawdown occurred during the summer season. The maximum drawdown of 30 feet for the formulated project occurred twice in 40 years of streamflow record, in September-December 1930 and October-December 1963.

Table 4-8 displays drawdown during the major recreation season, based on the hypothetical reservoir operation for the period 1926-65.

Exhibit 4-18 shows the drawdown-frequency relationship for a conservation pool at elevation 1160. It indicates that the drawdown would be less than two feet about one out of every two years at 30 September. The drawdown at the end of August would also be less than 10 feet in four years out of five, less than 14 feet in nine years out of ten, and less than 19 feet in nineteen years out of twenty. Drawdown early in the summer is expected to be considerably less. For example, nine years out of ten the drawdown is expected to be less than one foot on 30 June and less than six feet on 31 July, compared to a drawdown of less than 14 feet on 31 August.

Available data on existing projects indicate that attendance is affected by drawdown. Nevertheless, these data demonstrate that recreationists are using large bodies of water despite sizeable fluctuations in water surface. There is no doubt that the quality of a recreation experience can be impaired by these fluctuations. Further, drawdown may lead to loss of attendance where there are competing bodies of water within reasonable travel distance. At the present time, the overt effects of drawdown upon outdoor recreation are largely measured in terms of esthetic value judgements. In spite of drawdown (within limits), facility design and location measures may be taken to partially offset its detrimental effects upon recreation.

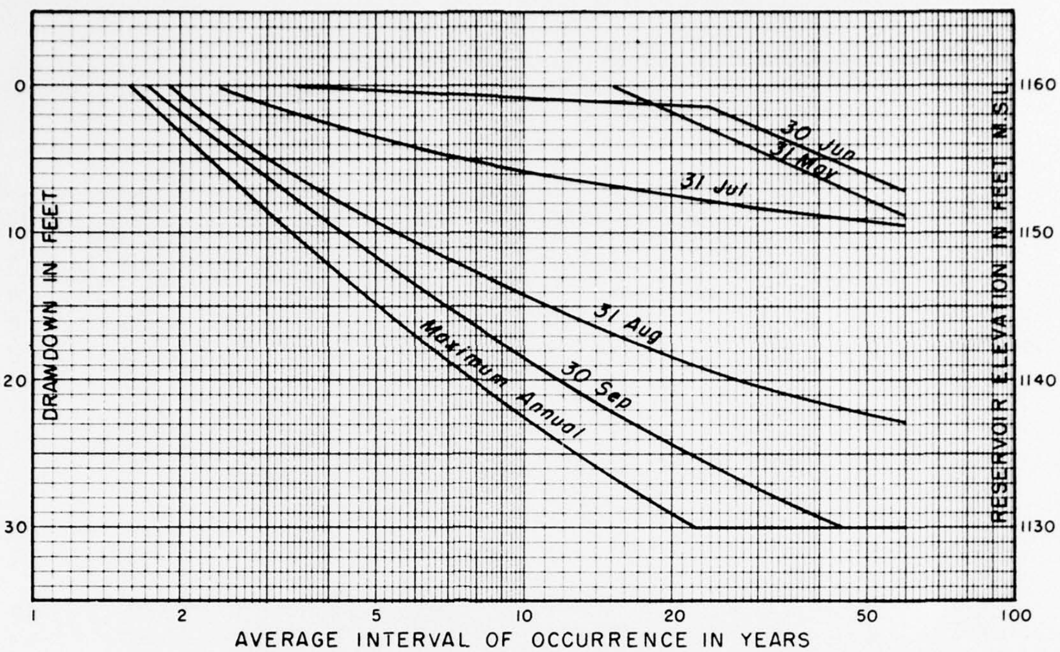
TABLE 4-8

RECREATION SEASON DRAWDOWN

Year	Drawdown, in feet, below top of conservation pool level (elev 1160) at end of month noted				Year	Drawdown, in feet, below top of conservation pool level (elev 1160) at end of month noted			
	May	June	July	August		May	June	July	August
1926	0	1	3	3	1946	0	0	0	3
1927	0	0	0	0	1947	0	0	1	0
1928	0	0	0	0	1948	0	0	0	0
1929	0	0	0	1	1949	0	0	0	0
1930	0	1	10	22	1950	0	0	0	0
1931	9	7	7	3	1951	0	0	0	1
1932	0	0	1	10	1952	0	0	1	1
1933	0	0	1	1	1953	0	0	1	7
1934	0	1	1	1	1954	0	0	0	7
1935	0	0	0	1	1955	0	0	0	1
1936	0	1	1	3	1956	0	0	3	10
1937	0	0	0	0	1957	0	0	4	13
1938	0	0	0	0	1958	0	0	0	0
1939	0	0	0	0	1959	0	0	2	3
1940	0	0	0	0	1960	0	0	1	2
1941	0	0	0	5	1961	0	0	0	0
1942	0	0	0	0	1962	0	0	0	0
1943	0	0	0	3	1963	0	0	7	18
1944	0	0	4	10	1964	0	1	6	19
1945	0	0	1	2	1965	0	0	5	12

From the above studies, it is concluded that drawdown at the Hipes project is a significant consideration. Further, it was concluded that drawdown greater than 10 feet is not desirable since public access to reservoir waters would be affected and possibly difficult to provide as a result of the reservoir shoreline topography. The precise extent of curtailment and the degree of difficulty that would be encountered to provide access at or beyond 10 feet remains to be determined. However, at the Hipes project, drawdown beyond 10 feet during the recreation season is not an annual occurrence. Indeed, drawdown at the end of August would be less than 10 feet four years out of five. Drawdown greater than 10 feet at the end of August occurred only 7 years of the total 40 years of record.

During dry years, troublesome spots will occur, particularly in the upper end of the reservoir. The use and control of water to adequately serve the water quality requirement, dictate that in order to derive maximum project benefits, the recreationist must at times be willing to accept a situation that cannot always be ideal. But, for those infrequent



NOTES:

1. Curves hereon indicate average interval of occurrence of drawdown elevations at, or lower than values shown.

2. Based on average monthly flows for period 1926-1965

COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION
DRAWDOWN FREQUENCY CONSERVATION POOL 1160 HIPES RESERVOIR SCALE AS SHOWN
Drawn by: R.H.B Checked by: C.D.M. Date: JANUARY 1968

periods when the stated limits of drawdown are exceeded, it is firmly believed that a visitor to the project will still attain a memorable experience with minimal curtailment of his physical and aesthetic recreation opportunities. A subsequent section describing the concept of recreation planning for the Hipes project presents the excellent potential of reservoir waters and related lands to manifestly entrench recreation as a major project purpose.

Associated Trout Fishery and Rearing Station - There is an unsatisfied demand for trout fishing in the vicinity of the project. Studies by the U. S. Fish and Wildlife Service and the Virginia Commission of Game and Inland Fisheries indicate that Craig Creek downstream from Hipes Dam site would be suitable for trout provided a flow of not less than 80 cfs having a temperature of not more than 68°F and a dissolved oxygen content of not less than 5 ppm were maintained. The Hipes Reservoir would create a source of water to meet these requirements.

There is a need for additional trout rearing facilities to provide stock for streams in the western portion of Virginia, primarily in Appalachia. The environmental requirements for a trout rearing station are adequate lands and a water supply of 20 cfs with temperature not higher than 60°F. Suitable land would be available at Hipes between the dam and the spillway and the water could be provided. Recent surveys by State and Federal fishery agencies indicate that there is no other site available which would be more suitable than that below Hipes Reservoir.

The downstream trout fishery on Craig Creek is expected to become one of Virginia's outstanding stocked trout streams. It is expected to furnish 12,100 fisherman-days annually.

Additional information on the downstream trout fishery and trout rearing station are provided in this chapter and in Appendix G.

Hipes Reservoir and Its Relation to Existing System - The studies to formulate the best major, multiple purpose project for development of the water resources of Water Sub-region C, which have been presented in preceding paragraphs, were predicated on construction of Gathright in accordance with the present plan. Investigations of the feasibility of modifying the plan of development of Gathright are discussed in the following paragraphs.

The Gathright project as being constructed will provide: substantially complete control of flood flows at the site; storage for water quality control sufficient to meet the needs at Covington to about year 2020 and at Lynchburg and Richmond to 1980; and, facilities for development of the recreation potential. The storage to be provided for flood control and water quality control as presently planned has been determined by needs on the Jackson River. Since these needs could not be served by Hipes Reservoir, modification of the amount of storage to be provided for flood

control or reduction of the amount of storage to be provided for water quality control need not be considered. Increasing the storage to be provided for water quality control is physically feasible. Greater storage could be used to provide additional water quality control benefits, primarily on the James River, or to permit a reduction in drawdown at Hipes and thereby increase the recreation benefits provided by that reservoir. However, recreation benefits provided by Gathright would be reduced by increasing the storage provided for water quality control. The amount of land having a slope sufficiently gentle to be suitable for recreational development is limited at this reservoir. The elevation of the top of the conservation pool as now planned provides the optimum combination of developable land and water area for recreation. The subsequent evaluation of the economic merit of modifying Gathright to provide greater storage for water quality control takes into account the effect on recreation benefits as well as on water quality control benefits.

At the Hipes site, the project providing maximum net benefits has been determined to be a reservoir with the top of the conservation pool at elevation 1160 on the assumption that Gathright would be constructed as now planned. However, analysis of various heights of projects at Hipes site without water quality control as a purpose indicates that maximum net benefits would be provided by a project with the maximum conservation pool also at elevation 1160. Therefore, for any scale of development at Gathright, the plan of development of the water resources of the sub-region which will provide maximum net benefits will include a project at Hipes site with maximum conservation pool at elevation 1160.

The following plans of development have been evaluated to determine the economic merit of modifying the project now being constructed at Gathright site:

Basin Plan I - Gathright constructed as presently planned, Hipes constructed to the optimum scale for this plan as determined by studies discussed in preceding portions of this chapter.

Basin Plan II - Gathright maximum conservation pool raised 20 feet to increase water quality control storage. Hipes constructed as in Plan I.

Basin Plan III - Gathright maximum conservation pool raised 20 feet to increase water quality control storage. Hipes drawdown decreased by an amount such that the reduction in water quality control storage would equal the increase in storage at Gathright.

The economics of the alternative plans are summarized in Table 4-9. The principal factor being evaluated in this analysis is the effect of project modifications on the total benefits provided by the two-reservoir systems. Both reservoirs provide flood control and water quality control benefits along the James River. These benefits have been prorated to each reservoir on the basis of Hipes being the last added project in each plan.

TABLE 4-9

ECONOMICS OF BASIN PLANS

	BASIN PLAN I			BASIN PLAN II			BASIN PLAN III		
	Hipes	Gathright	Total	Hipes	Gathright	Total	Hipes	Gathright	Total
PROJECT DATA									
Elevation, feet above msl									
Top of dam	1187	1684.5		1187	1695.5		1187	1695.5	
Crest of ungated spillway	-	1668.5		-	1680.1		-	1680.1	
Top of spillway gates	1177	-		1177	-		1177	-	
Top of flood control pool	1175	1610.0		1175	1626.7		1175	1626.7	
Maximum conservation pool	1160	1582.0		1160	1602.0		1160	1602.0	
Minimum conservation pool	1130	1554.0		1130	1554.0		1145.7	1554.0	
Storage, 1,000 acre feet									
Sediment and inactive	115.7	63.0		115.7	63.0		171.1	63.0	
Water quality control	115.7	60.7	176.4	115.7	116.1	231.8	60.3	116.1	176.4
Flood control	73.3	79.9	153.2	73.3	79.9	153.3	73.3	79.9	153.3
AVERAGE ANNUAL BENEFITS, $1,000									
Flood control	$ 130	$ 370	$ 500	130	$ 370	$ 500	$ 130	$ 370	$ 500
Water quality control	490	584	1,074	276	859(a)	1,135	215	859(a)	1,074
Recreation	1,012	295	1,307	1,012	115(b)	1,127	1,100	115(b)	1,215
Total user benefits	$ 1,632	$ 1,249	$ 2,881	1,418	$ 1,344	$ 2,762 -119 (c)	$ 1,445	$ 1,344	$ 2,789 -92 (c)

(a) Does not include water quality control benefit from meeting needs at Covington which will arise after year 2020. The present worth of these benefits would be small.

(b) Due to rugged terrain, the recreation benefit is proportional to the limited amount of land suitable for recreation development. The amount of suitable land is reduced by raising the conservation pool above elevation 1582.

(c) Difference between total benefits of this plan and Plan I.

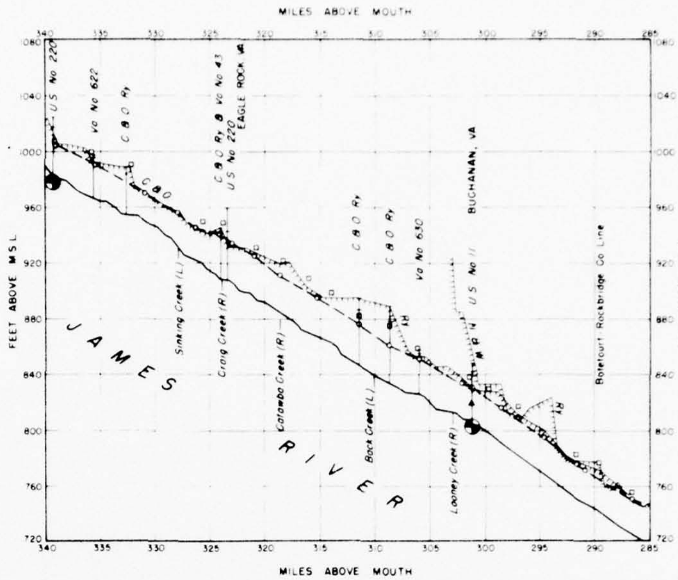
The analyses indicate that Basin Plan I would provide maximum user benefits. It would also provide maximum regional income expansion benefits since they are proportional to (a) the water quality control benefits at Covington which are substantially the same for all plans and (b) the system recreation benefits which are greatest for Basin Plan I. Basin Plan I would also be the least costly. Therefore, Basin Plan I, which includes Gathright project as now planned, is the best plan of development for the sub-region.

8. SELECTED PROJECT

Stream profiles of the upper James River and Craig Creek are shown on Exhibit 4-19. The Hipes Reservoir area is shown on Exhibit 4-20. It includes an earth and rock fill dam with a maximum height of 172 feet. A spillway would be located in a draw through the left abutment ridge. The concrete spillway crest would be surmounted by three tainter gates and the chute would be paved for a distance of 525 feet downstream from the crest. An intake tower with appropriate gates at several elevations would control the flow of water through the conduit. The reservoir would be 17 miles long and have an area of 4,540 acres at the level of the maximum conservation pool. The project would provide for the control of floods, low water regulation for water quality control, sediment retention, and water-based recreation. It would also provide the low-temperature outflow needed for a cold water trout fishery along Craig Creek from the dam to the mouth and a trout rearing station located immediately downstream from the dam.

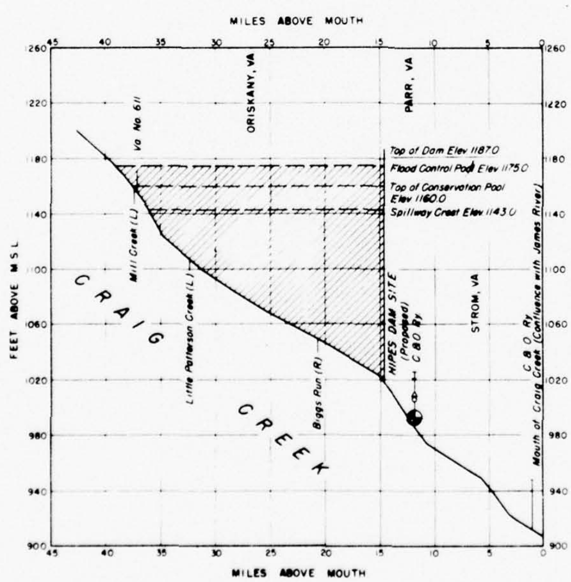
The project, together with Gathright, will reduce the flood problem along the upper James River in Water Sub-region C by 90 percent and a proportionately smaller amount downstream. It will meet the needs for an increased flow at Lynchburg for water quality control beyond year 2020 and at Richmond to year 1993. It will also provide a reservoir surface and nine adjacent recreation areas to satisfy a substantial portion of the water-based recreation needs in the region adjoining the project.

Two downstream projects are closely associated with Hipes Reservoir and are entirely dependent on it for the temperature control needed for their operation. These projects, the proposed downstream trout fishery and trout rearing station will be added assets to the reservoir project.



LEGEND

- RESERVOIR PROPOSED
- EXISTING RESERVOIR
- APPROXIMATE FLOOD PROFILE
- LOW WATER PROFILE
- RAILWAY PROFILE
- DECK } BRIDGE
- LOW MEMBER } BRIDGE
- STREAM GAGE
- HWM 1877
- HWM MAR 1913
- HWM MAR 1936
- HWM AUG 1940



COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

STREAM PROFILES

SCALE
AS SHOWN

Drawn by: RHB
Checked by: CDM
Approved: [signature]
Title: CHIEF, ENGINEERING DIV
Date: DECEMBER, 1967

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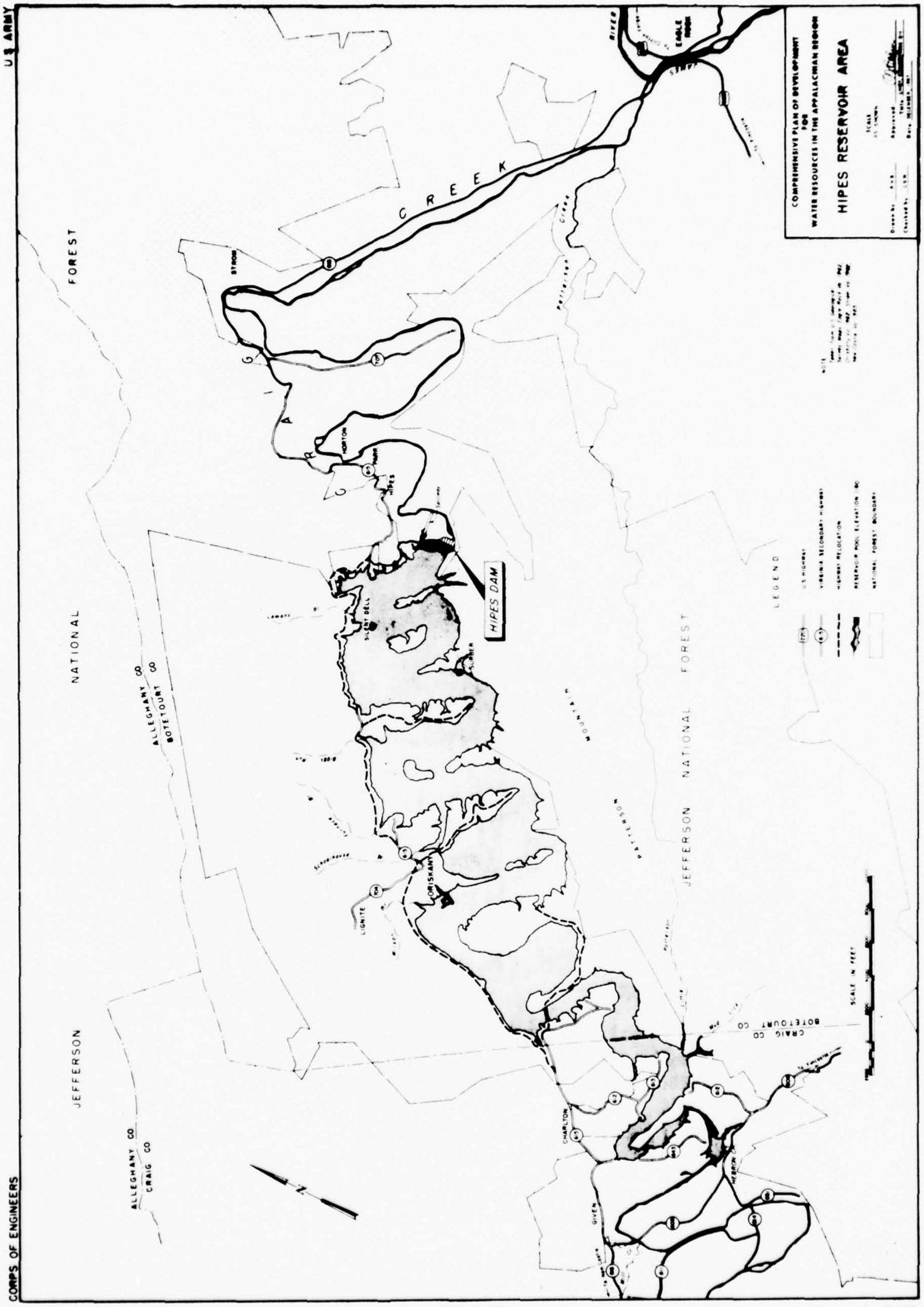

Exhibit 4-20

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SECTION III - DESIGN CONSIDERATIONS

9. INTRODUCTION

Detailed hydrologic, geologic, and cost analyses were made to determine the storage requirements and structural design of Hipes Dam and Reservoir project, to assure compliance with established design criteria and fulfillment of the proposed purposes at the least cost.

After these considerations, relocation and real estate acquisition requirements were estimated in accordance with criteria pertaining thereto. The proposed recreation development of the contiguous area was based on the estimated needs and suitability of available locations.

10. HYDROLOGIC

Hydrologic analyses were made to determine the storage allocations needed in Hipes Reservoir to accomplish the proposed project purposes and to establish the hydraulic design of the structure. These analyses include evaluations of available hydrologic records and preparation of hypothetical floods used for structural design. A brief description of hydrologic characteristics of the project area and design data for the dam and reservoir follow.

General Climatology - Climatological and meteorological records are obtained from stations maintained and operated by the Weather Bureau of the Environmental Science Services Administration and are available in their publications.

The climate is temperate, characterized by warm summers and rigorous, but not severe, winters. Sub-zero temperatures occur annually. Selected station locations are shown on Exhibit 4-1.

Climatological Records - There are 14 stations near Hipes project site with 30 or more years of record. Three of these stations were selected as a basis for design and their records are summarized in Table 4-10.

TABLE 4-10
CLIMATOLOGICAL DATA FOR SELECTED STATIONS

			Average	Annual		
Station	Elev. (Feet msl)	Record Began	Temp. (F.)	Precip. (in.)	Snow-fall (in.)	Maximum 24-hour Precip.
Buchanan, Va.	875	1893*	56.8	44.20	18.5	5.68
Hot Springs, Va.	2197	1892	51.2	41.38	25.0	5.85
Union, W.Va.	1975	1902	52.1	36.23	23.9	4.10

* Broken record

Temperature - The project lies within the temperate zone, experiencing warm summers and rigorous, but not severe winters. Extreme temperatures range from 107° recorded at Buchanan, Va., to 20° below zero at Hot Springs, Va. The mean annual temperature over Craig Creek is 54°.

Precipitation - The average annual precipitation over the Craig Creek watershed is about 40 inches, and it is reasonably well distributed throughout the year.

Snowfall - Snowfall amounts in the project area vary from about 17 inches per year in the valleys to about 35 inches or more along the ridges. Snow accumulation is of little or no consequences insofar as affecting the runoff regimen of streams.

Storms - The region is subject to flood-producing storms during all seasons of the year; however, the frequency of storms is significantly greater during the spring and winter months.

Types of Storms - The sustained winter and spring storms generally produce the larger floods in the area, particularly along the main streams. Although not as intense as the convectional type storm, these storms are of longer duration and usually extend over the entire region, and, due to the orographic configuration of the region, flood conditions are accentuated along the main stream. Summer thunderstorms also result in flood conditions, particularly along the tributary streams, as they are generally more local in nature than the spring and winter storms. South Atlantic hurricanes in the late summer and fall approach the region from the south and east; however, their potential for producing floods in the region is diminished by the Blue Ridge Mountains. A great storm also occurred west of the Blue Ridge Mountains in August 1969. These mountains act as a barrier by shunting the storms northeastward and away from the region, and by inducing precipitation on the eastern side of the Blue Ridge.

Major Experienced Storms - The maximum flood during 43 years of record at the Craig Creek gage at Parr (See Exhibit 4-1) resulted from the storm of January 1935. A storm occurring in late March of 1913 produced record floods on the Jackson and Cowpasture Rivers. Below the confluence of these streams, along the James River, stages were the highest since the historical flood of November 1877. This storm demonstrated that severe flood-producing rainfall can occur west of the Blue Ridge Mountains. Other notable storms occurred over the Jackson and Cowpasture sub-basins in March 1936 and in May 1942. Severe flooding in the Craig Creek area was caused by the hurricane-spawned tropical storm of August 1940, which produced record flooding in the Roanoke River Basin to the south.

Initial Losses, Infiltration and Unit Hydrographs - It is not possible to determine precisely the average rainfall (and accompanying losses) over a watershed, because of the distance between rainfall stations and varying topography. However, studies in connection with

derivation of unit hydrographs in the area indicate initial losses of 0.4 inch to 1.5 inches and infiltration losses of 0.04 to 0.08 inch per hour. Losses are significantly greater in the summer and fall months when vegetative growth is rankest, and less in the winter and spring months, when brush and trees are bare and ground cover is at a minimum. Exhibit 4-21 summarizes the derivation of a unit hydrograph for Craig Creek at Parr and includes information on losses experienced in that watershed. A conservative value of 0.8 inch initial loss and 0.05 inch per hour infiltration capacity is applied to the rainfall increments of design storms.

Runoff - Runoff throughout the region varies from 12 to 18 inches annually. At Buchanan, the average runoff of the James River is 16 inches, or about 39 percent of the average annual rainfall. Monthly and annual runoffs and maximum floods at gaging stations used in design of the Hipes project are shown in Table 4-11, and their locations are shown on Exhibit 4-1.

TABLE 4-11
RUNOFF AND FLOOD DATA

Stream and Station	D.A. (Sq. mi.)	Years of Record	Annual (a) Runoff (in.) Mean	Max.	Min.	Gage Datum (msl)	Maximum Flood Stage (ft.)	Disch. (cfs)
James River Lick Run	1,369	40	15.59	25.52	7.87	978.30	25.65	66,600
Craig Creek Parr	331	40	15.29	26.51	8.43	992.50	17.00	19,100
James River Buchanan	2,084	67	16.05	26.95	8.61	802.90	31.0	105,000

(a) Through September 1965.

Stream Characteristics - Craig Creek, a major right-bank tributary, enters the James River about 19 miles below Clifton Forge. Water quality is very good. Characteristics of the stream are shown in Table 4-12.

TABLE 4-12
STREAM CHARACTERISTICS - CRAIG CREEK

Location	Drainage Area (sq.mi.)	Miles Above Mouth	Reach Length (miles)	Average Slope (ft./mi.)
Mouth (Mile 323.7 James River)	374	0	72.0	
Parr Gage	331	11.8	60.2	12.0
Hipes Damsite	327	14.8	57.2	

Existing Reservoir Storage - The Gathright Project (under construction - completion scheduled for fiscal year 1973) will provide 63,000 acre feet of inactive storage, 60,700 acre feet of conservation storage; and 79,000 acre feet of flood control storage plus an additional 222,400 acre feet between the top of the flood control pool and the spillway crest. A Soil Conservation Service project on Johns Creek, which is essentially complete, provides about 5,300 acre feet of storage in four structures upstream from the headwaters of the proposed Hipes Reservoir.

Major Known Floods - The greatest known floods were those of January 1935 on Craig Creek and March 1913 on the James River Basin. Records of rainfall and stages are meager for the March 1913 flood. Some highwater marks are available and indicate that record, or near record, flooding extended over the entire region. Notable basin-wide floods occurred in August 1969, March 1936, and in May 1942.

Flood Frequencies - A comprehensive regional frequency analysis was made for the entire James River Basin, which includes Hipes Project area. Analyses were made in accordance with procedures described in "Statistical Methods in Hydrology," by Leo R. Beard, January 1962.

Main Stem - Natural - Regional analysis indicated that the best natural frequency curves for main stem stations were those based on Buchanan records and adjusted to a long term base station.

Modified Conditions - Modified frequencies were determined by routing a specific flood through Gathright and Hipes Reservoirs and then routing the holdout, or difference between the natural flow and the regulated flow at the reservoir, downstream. Table 4-13 indicates the modifications attributable to the Gathright Project (now under construction) and the proposed Hipes Project.

Existing Improvements and Effect on Hipes Project Design - Gathright Dam and Reservoir, now under construction, will drastically modify the flow regimen of the Jackson River and have a significant effect along the reach of the James River which includes the confluence with Craig Creek. Gathright Reservoir provides sufficient flood control storage to substantially reduce the discharges of all floods originating above that project. Reduction of flood flows of the James River at the mouth of Craig Creek, by Gathright Reservoir, would reduce the frequency and duration of conditions which would require withholding of releases from the flood control storage of Hipes Reservoir.

Water quality control releases from Gathright will be coordinated with those from Hipes. During an extreme unilateral drought affecting Hipes Reservoir it is anticipated that releases from Gathright could frequently be increased to alleviate any shortage from Hipes. Conversely, when Gathright drawdown would be excessive, supplementary releases from Hipes would often supply the deficiency in Gathright releases.

TABLE 4-13
DISCHARGE FREQUENCIES - NATURAL AND MODIFIED

Steam and Station	D.A.	(1)	Peak Disch. (1,000 Cubic Feet per Second) For Indicated Exceedance Frequency 100 Year	50 Year	20 Year	10 Year	5 Year	2 Year
					Channel capacity 5,000 cfs			
Craig Creek								
Parr	331	U	23.0	20.0	16.5	14.0	11.4	8.5
		H	5.0	5.0	5.0	5.0	5.0	5.0
					Channel capacity 33,000 cfs*			
James River	2,084	U	105.1	90.8	73.0	61.0	51.0	39.5
Buchanan		G	86.0	75.5	61.5	52.4	43.0	29.5
		G&H	65.5	57.5	47.0	39.5	32.0	22.5

(1) Condition - U, Unregulated.
G, Modified by Gathright Reservoir.
H, Modified by Hipes Reservoir.
G&H, Modified by both.

* Damages in urban area begin at 55,000 cfs

Flood Characteristics - Due to the mountainous terrain, runoff concentrates rapidly in the valleys and flooding tends to be flashy. During most storms, peak stages occur about 3 to 6 hours after runoff begins in the headwater areas of the region and from 18 to 24 hours at the downstream limit of the region. Flood heights remain at or near the peak for only a short time and return rapidly to within-bank stages. Data on stage, discharge, duration, and volume of floods at the Buchanan station are shown in Table 4-14.

TABLE 4-14
FLOOD DATA

Gage and Datum	Damage Stage (ft.)	Date	Gage Height (ft.)	Peak Disch. (1,000 cfs)	Days Above Damage Stage	Volume Above Base Flow Ac.Ft.	In.
James River	15.8	27 Mar 1913	31	105.0	2	211,000	1.9
Buchanan		18 Mar 1936	26.80	84.1	2	189,000	1.7
802.90		1 Mar 1902	25.0	76.0	2	322,000	2.9
		23 Jan 1935	23.82	70.4	2	211,000	1.9
		13 Mar 1963	22.30	61.8	2	178,000	1.6
		30 Dec 1901	19.2	55.0	2	211,000	1.9

Unit Hydrograph - Hipes Damsite - Unit hydrographs determined for Craig Creek at Parr, Va., are illustrated on Exhibit 4-21. The unit hydrograph at Parr is essentially that at the Hipes Damsite.

Runoff into Full Reservoir - A unit hydrograph of runoff into the full reservoir was obtained by dividing the watershed into various components and summing up the increments to obtain a composite for the land area. These components consisted of (a) the flow of Craig Creek at the head of the reservoir which was obtained by adjustments of the unit hydrograph at Parr, and (b) the lateral flow entering at the limits of the reservoir, which was developed by synthetic methods and (c) the precipitation which falls directly on the reservoir. A summary of the unit hydrographs of these components of inflow and the natural unit hydrograph at the damsite are shown in Table 4-15.

TABLE 4-15
SIX-HOUR UNIT HYDROGRAPH, HIPES DAMSITE
AND RESERVOIR INFLOW
(Discharge in 1,000 cfs)

Time in Hours	To Head of Hipes Reservoir - 288 sq. mi.	Lateral Flow into Reservoir 32 sq. mi.	Direct Fall on Reservoir (7 sq. mi.)	Total Inflow to Reservoir (Land Area - 327 sq. mi.)	Natural Flow at Damsite 327 sq. mi.
0	0	0	0	0	0
6	1.15	2.27	0.75 (a)	3.52	1.23
12	4.23	0.89	0	5.17	4.30
18	7.07	0.22		7.29	6.92
24	8.00	0.06		8.06	8.54
30	4.48	0		4.48	6.22
36	2.57			2.57	3.21
42	1.48			1.48	1.89
48	.93			0.93	1.22
54	.58			0.58	0.78
60	.33			0.33	0.48
66	.15			0.15	0.28
72	.06			0.06	0.11
78	.01			0.01	0.01
84	0			0	0

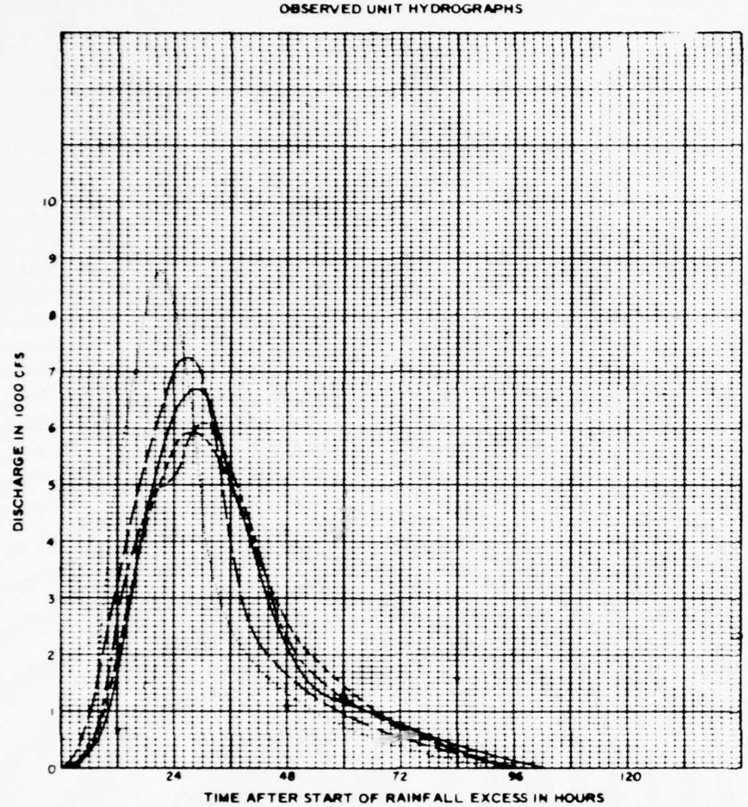
(a) Uniform rate of inflow for preceding 6-hour period.

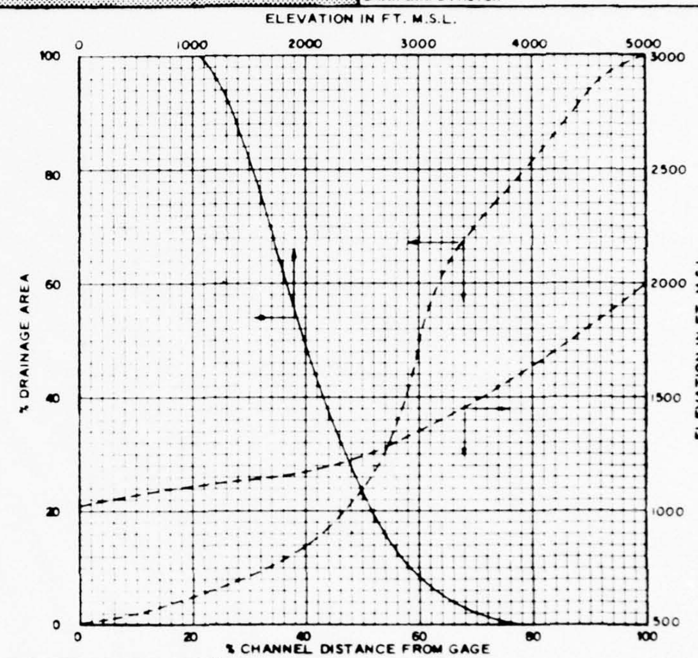
Droughts - Severe deficiencies of flow have been recorded at stream gages of the upper James River Basin. These usually occur during the last six months of the calendar year. An evaluation of the 40-year record of Craig Creek at Parr was made, by examination of the 67-year record of James River at Buchanan. The five most severe low-flow periods at Buchanan, for durations of 1 to 183 days, occurred during the last 38 years.

DEPARTMENT OF THE ARMY | CORPS OF ENGINEERS

DRAINAGE AREA CHARACTERISTICS			
DRAINAGE AREA	331 sq. mi.	L	57.1 mi.
MAXIMUM ELEVATION	4000 ft. m.s.l.	L_{ca}	34.3 mi.
MINIMUM ELEVATION	907 ft. m.s.l.	$(LL_{ca})^{0.3}$	9.7
MEAN ELEVATION (weighted)	ft. m.s.l.	DRAINAGE DENSITY	1.95 mi. / sq. mi.
LAND SLOPE	ft./mi.	MAP SCALE	
MAIN STREAM SLOPE	12.0 ft./mi.	METHOD OF FLOW SEPARATION	TYPE A
		BASIN SHAPE FACTOR	

OBSERVED UNIT HYDROGRAPHS





DATA FROM OBSERVED UNIT HYDROGRAPHS

DATE OF RAINFALL	LEGEND	AVE. P (in.)	RAINFALL EXCESS DURATION (hr.)	RAINFALL EXCESS AMOUNT (in.)	L_{cP} (mi.)	STAGE RECORD	Q_{pR} (c.f.s.)	Q_p w = hrs. (c.f.s.)	t_{pR} (hr.)	t_p (hr.)	t_v (hr.)	C_{tR}	C_{p640}	K_m (hr.)	T_c (hr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
14-16 MAY 1942	(1)	3.35	6	1.37	Dnstr	Rec	8,800	8,800	18	18	20	1.85	478	7.2	27
28-29 NOV 1948	---- (2)	2.35	18	1.09	Cntr	Rec	5,950	8,350	18	19	17	1.86	324	15.7	27
3-4 DEC 1948	—— (3)	2.65	12	1.44	Cntr	Rec	7,300	8,200	21	21	20	2.17	465	10.0	25
12-13 APR 1949	—— (4)	2.60	15	1.65	Cntr	Rec	6,150	7,850	21	21	22	1.96	390	9.3	31
16-17 MAR 1936	—— (5)	4.40	18	2.03	Dnstr	Rec	6,700	7,900	20	18		2.01	394	12.6	27

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

CRAIG CREEK AT PARR, VA

UNIT HYDROGRAPHS

Drawn by R.H.B. Checked by C.D.M. Date DECEMBER 1967

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Therefore, Craig Creek recorded low flows are considered to be reasonably severe. A measure of the severity of a drought is difficult to express since it is made up of low flows in periods of varying durations, and the flow in each period of a given drought year could indicate a different frequency. An estimated low flow-duration-frequency relation for the Craig Creek at Hipes Damsite, based on records at the nearby gaging station at Parr is shown in Table 4-16.

The lowermost portion of the table shows the five most severe periods and the year of occurrence of low flow during the 40-year period for durations of 1, 7, 30, 60, 120 and 183 days. They are ranked in order of severity, rather than chronologically. This table indicates that the drought of 1930 was the most severe of record for durations of 60 days and longer, and considerably more severe than the next lowest drought for a six-month duration, 183 days. Generally, the drought of 1930 would have a frequency of about once in 100 years for the longer durations and would occur more frequently for shorter durations. The next lowest drought is not well defined, as the flows various durations occur in several different years.

TABLE 4-16
DROUGHT PERIODS - CRAIG CREEK AT HIPES DAMSITE

Estimated Occurence Frequency in Years	Duration of Period in Days					
	1	7	30	60	120	183
			Average Discharge in cfs			
2	47	49	58	70	95	135
5	35	37	41	47	60	84
10	31	33	37	41	51	71
20	28	30	33	37	44	61
50	26	27	30	33	38	53
100	24	25	28	31	34	47
			Lowest Flows Recorded			
Severity Rank						
1	27-1964	27.1-1964	32.3-1932	35.2-1930	36.3-1930	42.2-1930
2	29-1930	30.6-1963	33.3-1930	35.4-1932	41.7-1963	51.4-1960
3	30-1932	30.6-1932	33.4-1964	37.2-1944	43.9-1933	52.8-1933
4	30-1963	30.7-1930	33.4-1944	38.5-1964	44.0-1953	53.0-1963
5	30-1944	30.7-1944	36.5-1933	39.7-1933	48.5-1960	54.8-1953

Storage Allocation to Proposed Purposes - The Hipes Project was designed to provide storage space for water quality control, flood control, and sediment deposit, and also to support associated recreation activities. The reservoir segments allocated to the various project functions are shown in the following tabulation:

Function	Capacity (ac.ft.)
Sediment Deposition	6,200
Inactive	109,500
Water Quality Control	115,700
Flood Control	73,300

Storage-Yield Relationship - The dependable yield obtainable from Craig Creek with regulation by varying amounts of storage is shown on Exhibit 4-5. The curve shown was derived by routing the flows recorded at the Parr gage through the reservoir with various release rates, during the periods when streamflow was below normal. Durations of 30 to 1,719 days were used to establish critical relationships.

Water Quality Control - The flow required for water quality control is shown in Table 4-17. Also shown is the storage required to provide the flow, with a probability of inadequacy of one month in 20 years.

The storage required was determined by reservoir operation studies based on flows recorded during the period 1925-1965. The time required for water released from Hipes Reservoir to travel to Lynchburg and Richmond is estimated as 5 days and 12 days, respectively. In actual operation, the release from Hipes at any time would be based on a forecast of flow which originates from the uncontrolled drainage area above the needs center, the forecast period being equal to the time of travel. In the operation studies, releases from the reservoir were based on flow from the uncontrolled drainage area estimated as equal to those which would be forecast in actual operation. Allowance has also been made for (a) consumption of water withdrawn from streams as projected by the Soil Conservation Service and (b) flow regulation by 60,700 acre feet of conservation storage at Gathright Reservoir operated to provide flow required at Covington.

The conservation storage to be provided in Hipes Reservoir, 115,700 acre feet, was selected on the basis of project formulation studies described in Section II of this chapter.

Flood Control - Hipes Reservoir would provide 73,300 acre feet of storage for the control of floods. This storage will be adequate to prevent flood releases from contributing to the peak of flows on the James River below Hipes Dam in all except the very rare floods.

TABLE 4-17
FLOW AND STORAGE REQUIRED FOR WATER QUALITY CONTROL

	Flow Required in cfs					
	Lynchburg			Richmond		
Month	Present	1995	2020	Present	1995	2020
Jan	220	300	320	(a)	300	400
Feb	240	300	380	(a)	300	400
Mar	290	370	450	(a)	300	500
Apr	420	550	650	(a)	650	950
May	460	620	720	(a)	1,000	1,250
Jun	690	900	1,100	(a)	1,450	1,650
Jul	690	900	1,100	(a)	1,550	1,800
Aug	690	900	1,100	(a)	1,550	1,800
Sep	580	750	900	(a)	1,350	1,550
Oct	450	580	700	(a)	900	1,150
Nov	300	380	470	(a)	300	600
Dec	250	320	400	(a)	300	400
Storage Required, AF (b)	0	48,000	85,000	0	135,000	182,000

(a) Less than minimum flow of record.
(b) In addition to 60,700 AF at Gathright Reservoir.

Sediment - The suspended sediment load of the James River has been measured at Buchanan, Virginia, the measurements being made by the U. S. Geological Survey from May 1951 to September 1956. Analyses of these and similar data collected within the same physiographic province, from streams to the north and south of Craig Creek indicate an annual sediment yield of 0.2 acre foot per square mile of drainage area above Hipes Damsite. These data also indicate that about 90 percent of the sediment particles will be in clay and silt size ranges and the remainder sand. The capacity of Hipes Reservoir will be large in relation to inflow and it is estimated that 95 percent of the inflowing sediment will be deposited. Thus the volume of sediment expected to be deposited in Hipes Reservoir is 6,200 acre feet per 100 years. Experience at existing reservoirs similar in operation and gradation of inflow sediment indicates that almost all of the sediment will be deposited below the top of the conservation pool. The volume of sediment expected to be deposited in 100 years is only two percent of the capacity below that elevation. Therefore, sedimentation will have no significant effect on the life of the reservoir or allocation of storage.

Area and Capacity Curves - The areas of Hipes Reservoir were determined for various elevations from multiplex maps prepared in 1943 to a scale of 1:20,000 with a contour interval of 25 feet. An electronic computer was used to interpolate areas at other elevations and compute capacities to derive the area-capacity curves shown on Exhibit 4-6.

Standard Project Flood - A standard project flood was developed for Hipes Reservoir from generalized estimates of rainfall and procedures outlined in Civil Engineer Bulletin No. 52-8. Due to the relatively small area and rapid runoff, rainfall durations in excess of 48 hours in the standard project storm were not considered pertinent. Losses of 0.8 inch initially plus 0.05 inch per hour infiltration capacity were subtracted from the rainfall amounts. Rainfall excess amounts so obtained were applied to appropriate unit hydrographs to obtain the flood hydrograph. This resulted in a rainfall of 12.77 inches, runoff of 9.73 inches, and peak natural flow of 79,000 cfs. Pertinent data on this flood are shown in Table 4-18.

Spillway Design Flood - A spillway design flood was computed from generalized estimates of probable maximum precipitation as contained in Hydrometeorological Report No. 33 of the U. S. Weather Bureau dated April 1956. Rainfall losses of 0.8 inch initially plus infiltration loss of 0.05 inch per hour were deducted and resulting rainfall excess amounts applied to the appropriate unit hydrographs. This resulted in a rainfall of 24.75 inches and runoff of 21.55 inches, with peak natural and reservoir inflow of 166,000 cfs each. Pertinent data on this flood are shown in Table 4-18.

TABLE 4-18
HYPOTHETICAL STORM AND FLOOD DATA - HIPES RESERVOIR

Item	Flood	Flood
Rainfall, Inches	12.77	24.75
Loss, Inches	3.04	3.20
Runoff, Inches	9.73	21.55
Peak Discharge, cfs		
Natural	79,000	166,000
Inflow	76,000	166,000
Outflow	53,000	136,000
Maximum Reservoir Elevation, ft. msl	1176.4 1/	1182.0 2/

1/ Assume pool at elevation 1160 at onset of flood.
2/ Assume pool at elevation 1175 at onset of flood.

Spillway Width Vs. Embankment Height - A gated spillway is proposed for the release of flood waters in extremely large floods so that the conservation pool can be established at as high a level as possible and maximum flood storage space be provided at the site. The spillway would be located in a low point or saddle on the north bank at the extreme end of the dam and releases would flow down a ravine on the downstream side of a knoll which separates the ravine from the dam. The selection of the

exact spillway width and height is dictated to a large extent by the configuration of the site. The maximum water level of the spillway design flood, and consequently the height of embankment, would not vary more than a few feet in any gated spillway which would reasonably be considered. Therefore, extensive routings were not deemed necessary during this study.

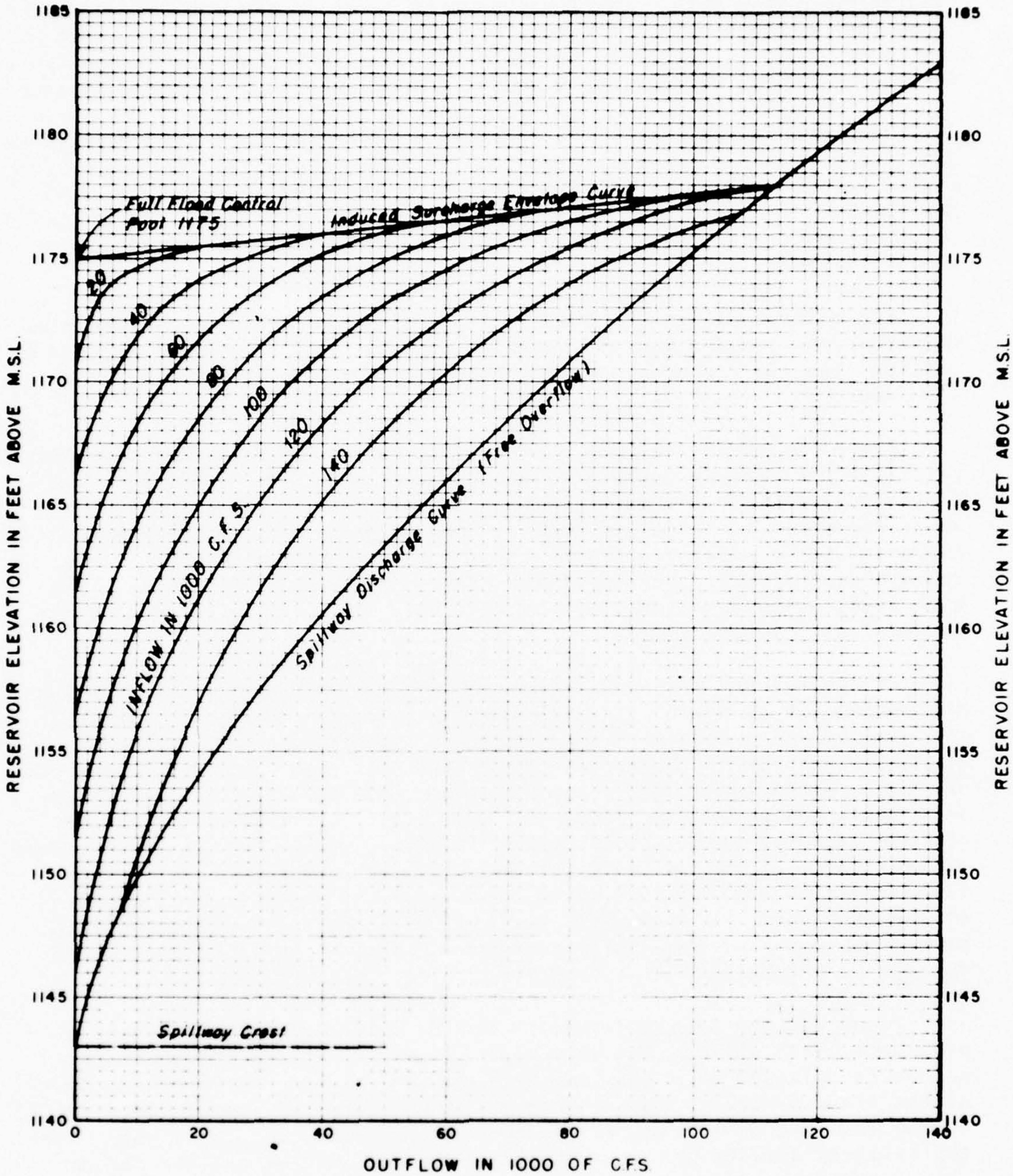
Recommended Spillway - The recommended spillway is a gated structure consisting of three tainter gates each 50 feet wide by 34 feet high with top of gates at elevation 1177 and crest of spillway at elevation 1143. The rating curve for this spillway is shown on Exhibit 4-22. Establishing the top of gates at elevation 1177 would provide two feet of operational freeboard above the top of the flood control pool.

Geologic conditions of the spillway discharge channel are discussed in paragraph 11 and structural details in paragraph 12. Profiles of the spillway and its approach and discharge channels are shown on Exhibits 4-10 and 4-26.

Flood Routing Conditions - The outlet gates controlling flows through the 17.5-foot diameter conduit would be able to release 5,000 cfs, the capacity of the creek channel, with the reservoir at elevation 1160. Water impounded in the flood control pool during minor and moderate floods would be released through the conduit unless subsequent floods require discharges in excess of the capacity of the outlet works. The high-level spillway gates would be used only during major floods or a succession of lesser floods.

It was assumed that all releases would be made through the spillway in routing the standard project and spillway design floods, and that use was made of a tentative gate regulation schedule which assured an induced surcharge of three feet at the time the gates were fully opened. The gate regulation schedule used is shown on Exhibit 4-22. The reservoir level was assumed to be at the top of the flood control space at the beginning of the spillway design flood and at the bottom of the flood control space at the beginning of the standard project flood. While flood releases are expected to be large enough to permit rapid emptying of the reservoir, an assumption was made that the reservoir was filled at the beginning of the spillway design flood in order that the top of the dam be established at a conservatively high elevation.

Flood Routing Results - Over 4 inches of flood control storage is provided. Thus all but the very rare floods can be completely stored and later released at a time and rate which will not contribute to downstream flood damages. During very large floods which contain more runoff volume than can be stored, it may become necessary to release water over the spillway earlier and at a greater rate than in the smaller floods. This discharge will be made as dictated by the gate regulation schedule which assures an induced surcharge of three feet before the spillway gates are fully opened.



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

GATE REGULATION SCHEDULE
HIPES RESERVOIR

Spillway Design Flood - The spillway design flood was routed through the reservoir assuming the flood control space was filled at the beginning of the flood and using the tentative gate regulation schedule. This resulted in a maximum reservoir level of elevation 1182.0 and maximum outflow of 136,000 cfs as shown in Table 4-18. Exhibit 4-23 illustrates the results of routing the spillway design flood through the Hipes Reservoir.

Standard Project Flood - The standard project flood was routed through the reservoir, assuming the reservoir level was at the bottom of the flood storage space and using the tentative gate regulation schedule. This resulted in a maximum reservoir level of elevation 1176.4 and maximum outflow of 53,000 cfs as shown in Table 4-18. Exhibit 4-24 illustrates the results of routing the standard project flood through the Hipes Reservoir.

Reservoir Regulation - Hipes Reservoir As a Unit in System - Hipes Reservoir would be operated in conjunction with Gathright Reservoir, which impounds runoff from 344 square miles near the head of the Jackson River. Flood control and water quality releases from Hipes would be coordinated with similar functions at Gathright. Pertinent data on the Hipes Project are shown in Table 4-19.

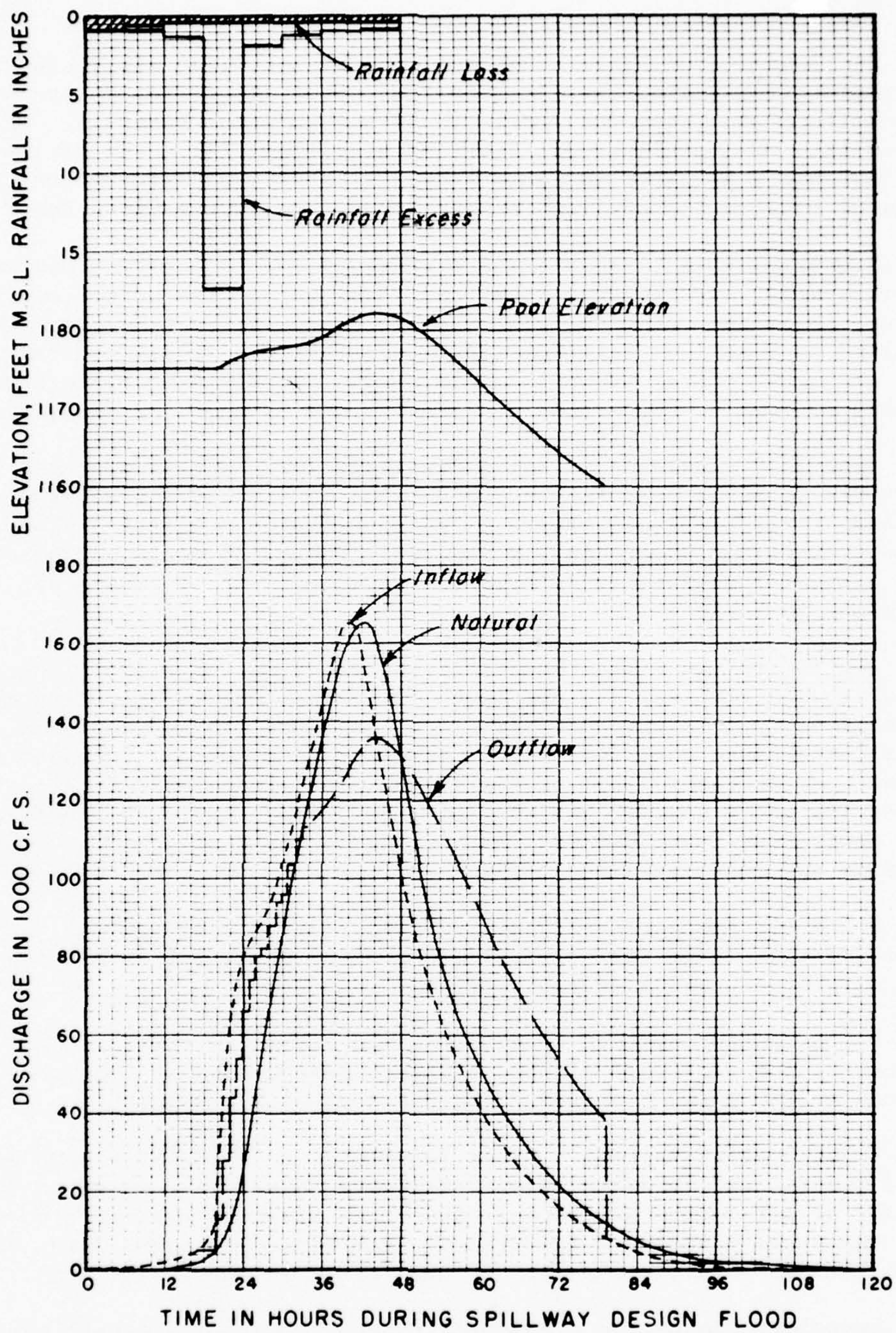
Control Points - The time of travel required for flow in the James River between Lick Run and the mouth of Craig Creek is approximately the same as that required for flow between Hipes Dam and the same point. It is anticipated that James River gages at Lick Run and Buchanan can be used as the control points for timing flood releases from Hipes. Releases for water quality and similar uses will be timed in accordance with downstream requirements. Damage stages and discharges at control stations are shown in Table 4-20.

Reservoir Regulation Effects - Hipes Reservoir would modify the extremes of flow downstream by decreasing flood peaks and augmenting low flow of streams during drought periods.

Flood Control - Hipes Reservoir would store flood waters, and, in all except the very rare floods, release these waters so that they would not add to the peaks from remaining portions of the watershed.

Water Quality Control - Hipes Reservoir, with the Gathright Reservoir, would provide the increased flows necessary to maintain water of objective quality at all points downstream with waste loads as projected to year 2020 except at Richmond. At Richmond, the projected waste loads will equal the assimilative capacity of the stream in about year 1993.

Hydrologic Network - A hydrologic network would be established to provide (a) current reporting of precipitation data, (b) records of reservoir inflow and outflow, (c) records of dissolved oxygen and temperature in the reservoir and in the outflow, (d) current information on streamflow at Lick Run and Buchanan, Va., and (e) information on streamflow and water quality at Lynchburg and Richmond.



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

SPILLWAY DESIGN FLOOD
HIPES RESERVOIR

Drawn by: RHB

Checked by: CDM

Date: DECEMBER 1967

Exhibit 4-23

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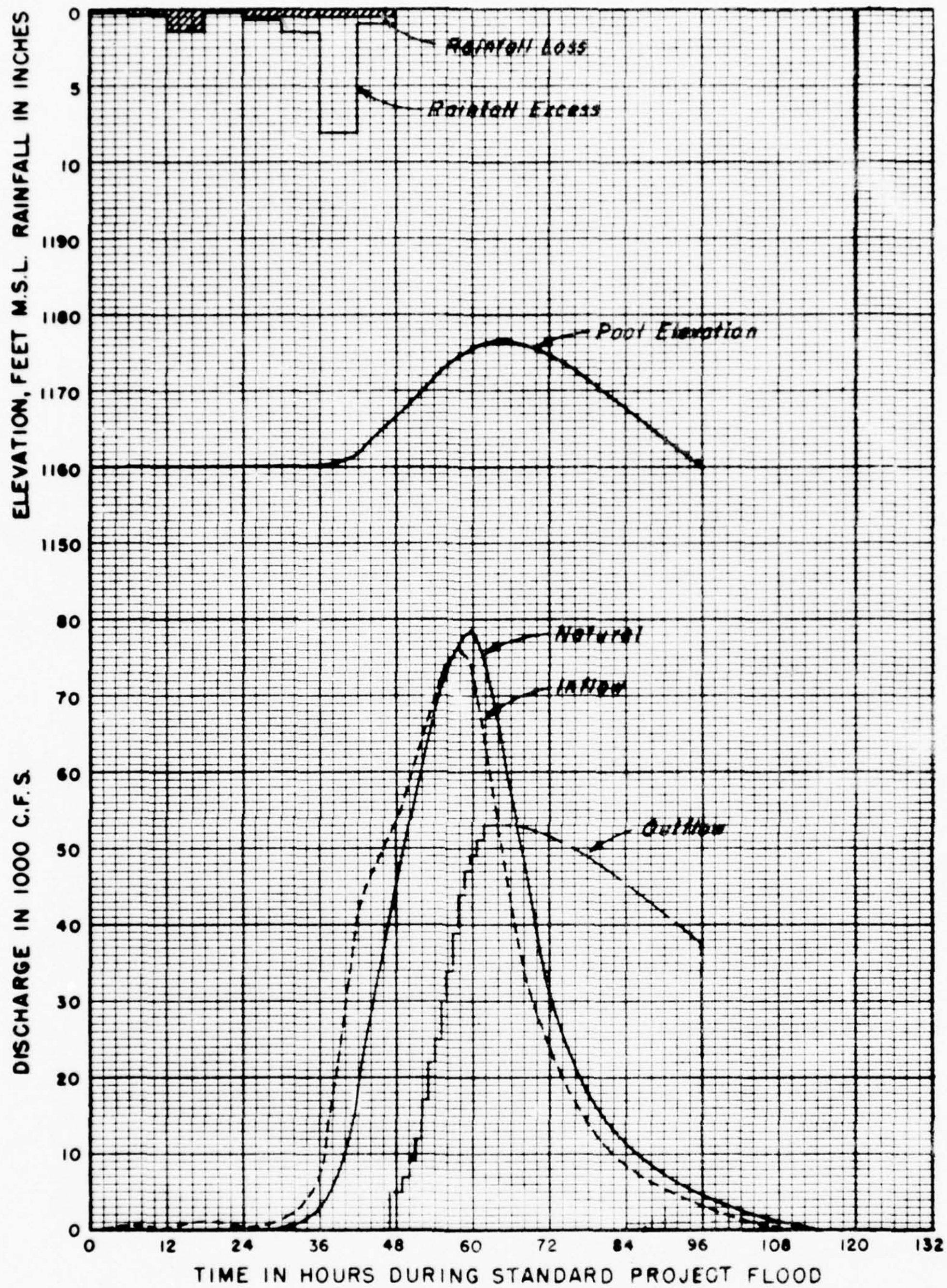


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

STANDARD PROJECT FLOOD
HIPES RESERVOIR

Drawn by: R H B.

Checked by: C D M

Date: DECEMBER 1967

FILE: GH0106-0

Exhibit 4-24

TABLE 4-19
PERTINENT DATA, HIPES PROJECT

Project purposes:	Flood control; water quality control; recreation
Location of dam, miles above mouth:	14.8
Drainage area, sq. mi.	327
Type of dam	Earth fill
Spillway	High level, gated, 3 gates 50 ft. wide by 34 ft. high, crest elevation 1143, top of gates elevation 1177.
Outlet Works	17.5 ft. round tunnel, flood releases controlled by two 4 x 6 ft. gates. Tower with multi-level intakes for water quality control, which discharges into tunnel.
Channel capacity	5,000 cfs
Elevations, ft. msl	
Top of dam	1187
Spillway design flood	1182.0
Land acquisition	1180 (a)
Standard project flood	1176.4
Top of spillway gates	1177
Full flood control pool	1175
Maximum conservation pool	1160
Crest of spillway	1143
Minimum conservation pool	1130
River bed	1013
Reservoir area, acres	
Spillway design flood	5,630
Land acquisition	8,790
Top of spillway gates	5,250
Maximum conservation pool	4,540
Minimum conservation pool	3,170
Storage, acre feet (watershed inches)	
Flood control	73,300 (4.2)
Conservation	115,700 (6.65)
Inactive (b)	115,700 (6.65)
Total	304,700 (17.5)

(a) Or 300 feet horizontally from 1175 contour, including land for recreation.
(b) Includes 6,200 acre feet sediment storage.

TABLE 4-20
DAMAGE STAGES AND FLOWS AT CONTROL STATIONS

Control Station	Drainage Area (sq. mi.)	Datum of Gage (msl)	Crop Season Stage (ft.)	Crop Season Disch. (cfs)	Urban Area Stage. (ft.)	Urban Area Disch (cfs)
James River						
Lick Run	1,369	978.30	17.7	27,000	-	-
Buchanan	2,084	802.90	15.8	33,000	20.8	55,000
Craig Creek						
Parr	331	992.50	9.3	5,000		

Existing USWB and USGS stations would be incorporated in the network and establishment and operation of additional stations would be coordinated with these agencies.

11. GEOLOGIC

Surrounding Area Description - The Hipes Project is located on Craig Creek, a headwater tributary of the James River, in the Valley and Ridge province of Virginia.

The Valley and Ridge province of Virginia extends from the head of the James River drainage, along the West Virginia line, to the Blue Ridge province and has a width of about 40 miles. The area is drained by the James River. The principal tributaries above the Blue Ridge are Maury, Cowpasture, and Jackson Rivers from the north, and Catawba, Craig, Potts, and Dunlap Creeks from the south. Tributaries entering from the south are smaller than those from the north. Ridges are generally parallel and of similar height above the valley floors. Side hills and ridges are heavily wooded, and rock outcrops are common. The James River pursues a course transverse to the trend of the ridges and has cut gorges through the principal ridges.

Above Eagle Rock, at the mouth of Craig Creek, the topography is characterized by a repetition of ridges and valleys. These ridges are underlain by intensely folded sandstones, shales, and limestones of Ordovician, Silurian, and Devonian ages and have been formed by erosion controlled by the parallel orientation of folds. Generally, sandstones form the ridges and shales and limestones form the valleys. As most of the important streams in the Ridge and Valley areas are antecedent streams and have entrenched their courses across ridges, irrespective of rock types, topographic conditions are favorable for dam construction.

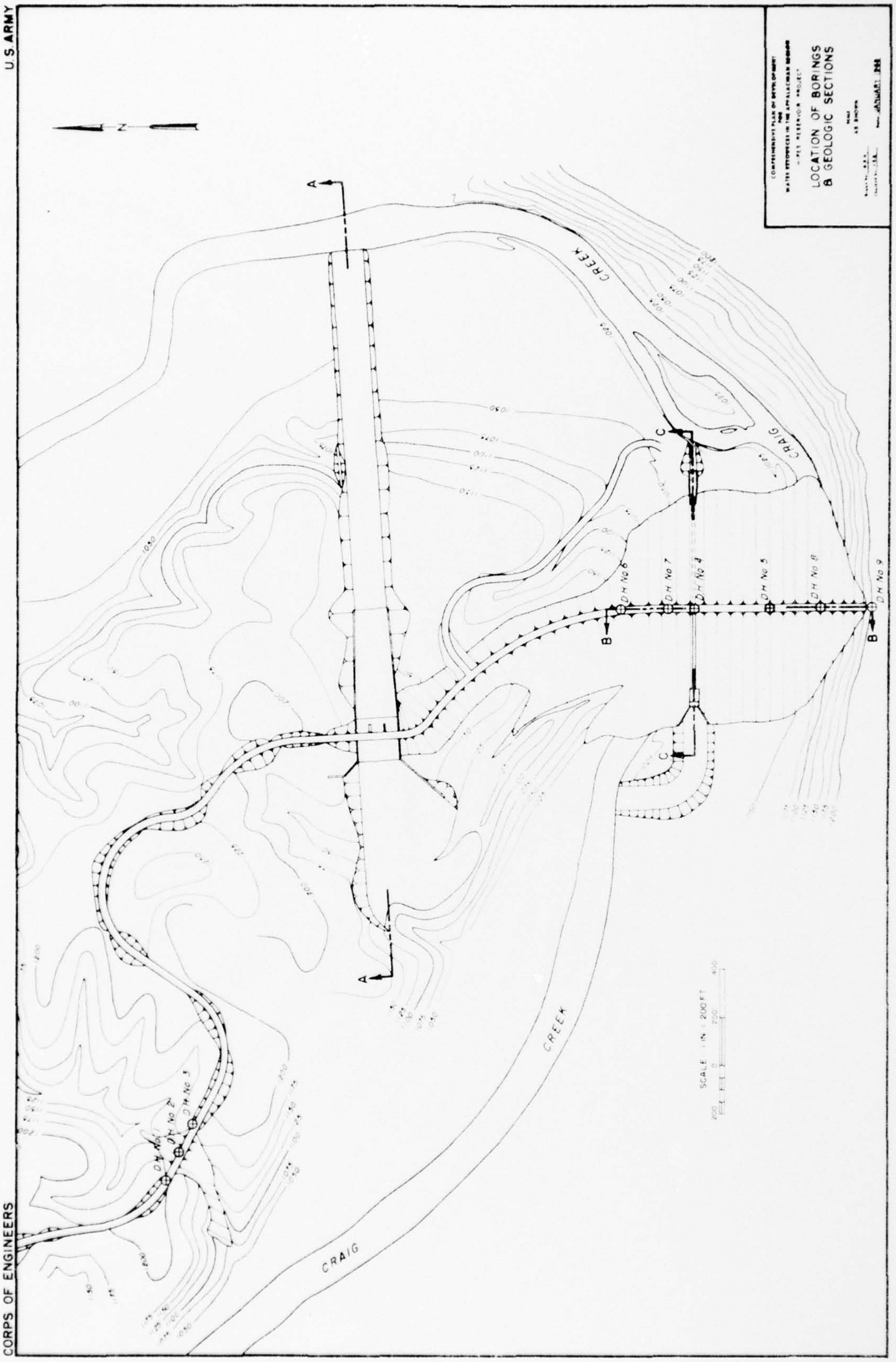
Area Geology - All of the rocks in the Valley and Ridge province are of sedimentary origin and range from Ordovician through Devonian in age. The entire area has been intensely folded into parallel ridges and valleys and subsequently eroded to the present patterns. The valleys of Potts and Craig Creeks, and of Cowpasture and Jackson Rivers, are broad synclinoriua of Middle and Late Devonian shales and sandstones. Unconsolidated deposits of Cenozoic age occur throughout the area in the form of talus on the steep ridges, broad apron-like deposits of sand and gravel on the lower slopes and in the valleys, and terraces and flood plain deposits along major streams.

General Project Description - The Hipes Project site is located on Craig Creek about 15 miles above its confluence with the James River. The dam would be in Botetourt County and the reservoir would extend upstream into Craig County. The project area is in the Valley and Ridge province, about 25 miles north of Roanoke.

The project occupies a valley which is underlain by thick deposits of Braillier shale of Devonian age. The soils in this area are classified as lithosoils and shallow soils, are poorly developed and are closely related to the parent rock which is shale. The entire reservoir area above the conservation pool is moderately-to-heavily wooded, with the exception of the proposed upper recreation site on the left bank, which is in grassed farmland. Erosion, silting, and sedimentation are not considered a problem insofar as recreation sites, marinas and beach areas are concerned, as runoff and subsequent erosion is retarded by the vegetative cover. It is noted, however, that present and future timber cutting operations and construction adjacent to these sites in the reservoir area may leave the uplands denuded. In this event, reseeding and reforestation may be required as the proposed sites are developed.

Craig Creek at the project site, as depicted on Exhibit 4-25, meanders in a northeasterly direction through a broad valley and has left low narrow ridges of shale within the meanders. The left abutment of the dam is one of these ridges, while the right abutment rests on the flank of Patterson Mountain, which is the ridge forming the eastern boundary of the entire valley. The height of the dam is limited by the left abutment subsidiary ridge.

Site Geology - A geological section along the axis of the dam is shown on Exhibit 4-26. All of the Hipes damsite is underlain by the Braillier shale of Devonian age. This formation, which has a thickness of several thousand feet, is composed of hard, well-cemented, greenish-gray silt shales and thin, hard, fine-grained sandstones. The foundation of the damsite is almost entirely shale. Variable strikes and dips are present as a result of local folding within the shale beds; however, the strike of the rocks, as determined from outcrops in the steambed a short distance below the site, is N45°E, and the dip is to the southeast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COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION
LOCATION OF BORINGS
& GEOLOGIC SECTIONS
AS SHOWN
JANUARY
N
A
B
C
DH No 1
DH No 2
DH No 3
DH No 4
DH No 5
DH No 6
DH No 7
DH No 8
DH No 9
CRAIG CREEK
SCALE 1 IN = 200 FT

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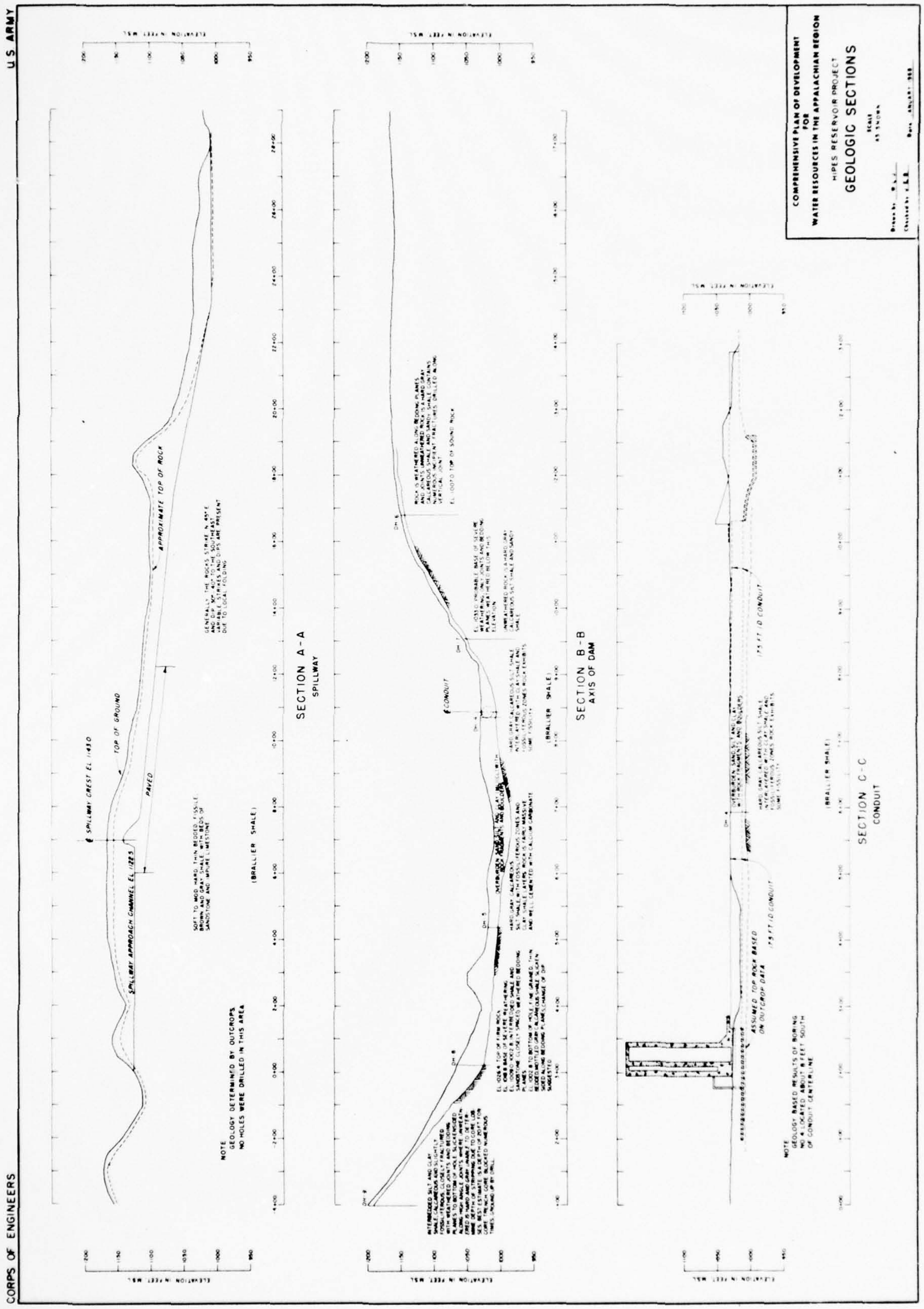

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at an angle of about 30 degrees. This is thought to be the general trend of the rocks. Therefore, the bedding is inclined downstream and into the right abutment in the damsite area. No details of structure have been developed, but apparently the entire area lies on the northwest limb of a large synclinal trough, and monoclinal dips to the southeast prevail. Deep weathering has taken place in the left abutment ridge and should be expected in the right abutment. However, the soil zones are shallow and in most places above the alluvial flood plains weathered shale is encountered 6 to 8 feet below the surface. In the area of the damsite, flood plains approximately 150 feet wide are present on both banks of Craig Creek. The flood plain deposits consist of 10 to 15 feet of sandy silt and clayey silt underlain by what appears to be, on the basis of the boring information, a bed of fragmentary rock or boulders about 9 feet thick.

At the damsite the Braillier is a hard, gray, calcareous silt shale and sandy shale with interbedded sandstones. Fissility ranges from sub-fissile to fissile, depending on the amounts of sand and calcium carbonate present. According to present boring data, base of severe weathering varies from a maximum of 72 feet in boring 6 on the left abutment, to a minimum of 20 feet in boring 9 which is high on the right abutment. The boring logs indicate poor core recovery for most of the borings. The cores are broken quite badly, but where unweathered the rock is hard and gray. There is evidence of core barrel blocking and much of the breakage and poor recovery is attributed to poor drilling methods, especially in the unweathered portions. There is no indication of any appreciable solution activity below the severely weathered zones; only slight iron stains are present along tight bedding planes and joints. Excavation in the overburden on the abutment slopes will encounter silt, clay, and shale fragments, whereas in the flood plain silt, clay and shale fragments overlie an apparent layer of boulders immediately above bedrock. Additional design drilling will be necessary to confirm the presence, extent, and details of this layer of boulders.

The spillway will be located in a gap through the left abutment ridge immediately adjacent to the dam and will discharge into a ravine trending east, emptying into the creek at a distance of 2,300 feet below the toe of the dam (See Exhibit 4-25). A geological section along the spillway is shown on Exhibit 4-26. As at the dam, the underlying rocks are Braillier shale.

The spillway will be gated and paved for 525 feet of its total length of 2,000 feet below the weir. Since the rocks strike northeast and dip to the southeast, water flow over the unpaved portion of the channel will be transverse to the strike and dip. Due to the infrequent discharge through the spillway the anticipated erosion of the discharge channel is not expected to endanger the structure or cause damage to adjacent properties.

Overburden thickness is expected to vary from 0 to 6 feet. Depth of severe weathering may be as much as 70 to 75 feet, based on a depth

of 72 feet in boring 6. Boring 2, which was drilled at the formerly proposed spillway west of the present location, shows steeply dipping bedding planes and closely spaced joints, all of which are highly ironstained. Therefore, local drag folds should be anticipated, which could result in more extensive weathering.

The outlet works will consist of a concrete intake tower and a cut-and- cover conduit under the dam (See Exhibit 4-25). A geologic profile is shown on Exhibit 4-26. The geologic conditions are similar to those for the dam. Most of the excavation required is anticipated to be in overburden, since top of sound rock in Boring 4, on the conduit alignment, is at elevation 1009.

A minor dike will be required to seal a gap in the left abutment ridge west of the spillway (See Exhibit 4-25). Foundation conditions will be similar to those at the spillway.

Subsurface Investigation - A total of six core borings were drilled along the dam axis by the Corps of Engineers during 1944 and 1949. In addition, three core borings were drilled in the left abutment at the previously proposed spillway location. No drilling has been done at the present spillway location. Nine soil samples were taken during the 1949 investigation to determine characteristics of the overburden materials present. Tests conducted include mechanical analyses, Atterburg limits, slow consolidated shear tests, and static compaction tests. Cores and test data from the 1949 investigation are available for analysis. (For locations of borings and soil sampling, see Exhibits 4-25 and 4-26). The overburden samples were obtained by drive sampling and augering, and from a test pit located along the slopes and in the flood plain. The soils were classified as CL, ML and GC.

Recent investigations consisted of field trips by the District Geologist to check the site and to become familiar with field conditions, and an examination of the cores and samples. There have been no improvements at the site since the drilling was performed.

All drilling, both in borrow areas and in core borings was for the purpose of obtaining samples for record purposes and for testing. Non-sample drilling was not performed.

Representative samples of overburden were taken from all core holes down to the top of rock. Coring was done well into sound rock with NX bits and the resulting core was consecutively stored in boxes along with the overburden samples, properly placed and marked. Core losses were measured and indicated. Additional borings will be required along the line of the conduit, along the spillway, and to explore the left abutment ridge.

Foundation Determinations - As previously noted, the abutments are deeply weathered. However, sound rock appears to exist not far below

the creek bed across the valley floor. Consequently, a good foundation for the concrete elements of the dam is available.

It is proposed to excavate a cut-off trench to top of rock along the axis of the dam. The underlying rock will then be sealed by a grout curtain to depths varying from 50 feet across the valley floor to 100 feet in the abutments. A similar program will be instituted along the left abutment ridge if future drilling indicates the need.

Reservoir Condition - The Hipes Dam would form a reservoir with a maximum conservation pool elevation of 1160 feet. The entire reservoir area is underlain by Devonian shales and flanked by high ridges of shales and sandstones on both sides. No problem of reservoir leakage is anticipated; however, the narrow left abutment ridge will be explored by drilling and pressure testing.

If provisions are made to cut off the valley fill and seal the weathered and fractured zones of the abutments, leakage will probably be small since all of the reservoir is underlain by relatively impervious shales and bounded on both sides by high ridges of shales and sandstones. Future design drilling and pressure testing will determine the type and extent of foundation treatment.

Construction Materials - Two sources of embankment materials are available. Weathered shale from required excavation is to be used to the extent available. This material will be supplemented as required by borrow from the area indicated on Exhibit 4-27. It is believed that by using alluvium from the flood plain in the core and the weathered shale in the outer zones, a satisfactory and stable embankment can be constructed.

Classification of borrow soils and extent of investigations were discussed previously.

The quantities of concrete required preclude development of aggregate sources specifically for the project. Investigations for the Gathright project have indicated acceptable limestone aggregate and manufactured sand to be available within reasonable hauling distance. Cement is available within economic hauling distance from a plant north of Roanoke, Virginia.

Hard Devonian and Silurian sandstone and limestone suitable for rock fill and riprap occurs along Rich Patch Mountain, 3 to 4 miles west of the site.

Mineral Resources Affected - The only mineral resource known to be in the area of the reservoir is iron ore, which was exploited to some extent up until 1925. Of all the prospects for mining located in the area, only one was found susceptible to flooding. However, the conclusions reached by the Bureau of Mines are that the Oriskany iron ore

in the area affected by the reservoir is too limited in volume and too inferior in grade to justify the underground work required for its extraction. While a very minor portion of the land may be subject to acquisition of mineral rights, the value should be too small to add significantly to the cost of land acquisition. A detailed report covering the subject is included in Appendix I.

Conclusions - Because of the impervious nature of the underlying rocks and the extensive areal coverage of these rocks, the site is well suited to the type of dam contemplated. Suitable materials are available within reasonable distances, and the foundation adequate for the loads to be imposed.

12. STRUCTUAL

Structural features are shown on Exhibit 4-10. The rolled earth and weathered rock dam would be built of selected materials from required excavation and from borrow areas. The dam would have a length of 2,400 feet from the right abutment to the spillway, but the 1,200 feet adjacent to the spillway would be more in the nature of a dike. Maximum height of the dam would be 172 feet, with the top elevation at 1187, 5 feet above the spillway design flood. The height of the left bank wing adjacent to the spillway would vary from 20 to 35 feet. The 30-foot wide crest would accommodate an 18-foot roadway with guardrails. Tentative plans call for side slopes of 1 on 3 both upstream and downstream, with riprap on the upstream slope from the top to 5 feet below minimum pool and on the downstream side from the bottom up to maximum tailwater elevation. An inclined interior sand drain will be incorporated in the downstream portion of the fill and will extend up to the elevation of the top of the gates. A short dike 120 feet long at the top having the same slopes and characteristics as the dam would be built in the saddle 1,900 feet west northwest of the spillway and 1,500 feet southeast from the state highway.

The spillway would be located in a draw through the left abutment ridge. Water would be discharged back to the creek 2,300 feet downstream from the toe of the dam. The spillway crest would be at elevation 1143 and would have 3 - 50-foot wide by 34-foot high tainter gates. The spillway would be concrete lined from 100 feet upstream from the crest to a point 525 feet downstream from the crest. The spillway would be designed to carry a discharge resulting from a maximum reservoir level of elevation 1182.

The outlet works would consist of an intake tower, a cut-and-cover conduit, and a stilling basin, situated on the left bank. The conduit would be 17.5 feet in diameter, sized to pass diversion flows. The control tower would have 2 - 4-foot by 6-foot sluice gates for regulation and passage of lesser flood flows. There would also be 10 additional 3-foot by 5-foot intake gates for selective discharge regulation. Eight of these would be distributed through the conservation pool to admit water

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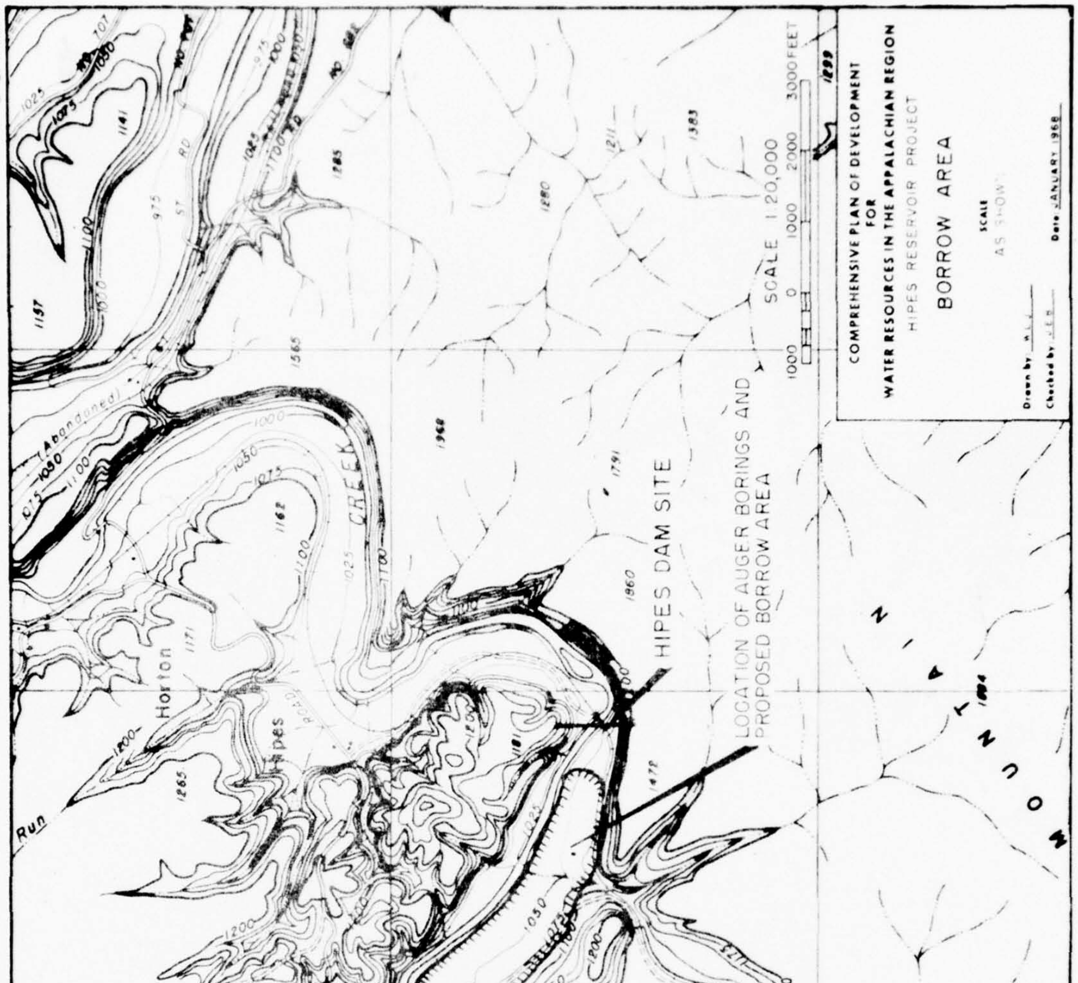

Exhibit 4-27

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of selected temperature or oxygen content to either or both of two wet wells. Results of current experiments and investigations will be considered in the selection of the elevations for the intakes to permit optimum blending of water from the epilimnial and hypolimnial zones. An additional 3-foot by 5-foot gate would be located in the base of each wet well, as deep as possible, to admit minimum temperature water for blending with water from the higher inlets. Flow from the wet wells would converge into a single channel controlled by sluice gates, and discharge into the conduit through the center pier downstream from the main sluice gates. A stilling basin sized to accommodate the maximum flow of the two main gates would be provided at the downstream toe of the dam. Access to the control tower would be by bridge from the crest of the dam.

A water supply system separate and independent of other project operations is planned for the trout rearing station. The plan would provide two bellmouth intakes in the face of the tower - one near the surface and one near the bottom of the reservoir. Each intake would have a regulating valve so that the temperature of the outflow could be controlled during periods when the reservoir is stratified. Water should be conveyed from the control tower to the rearing station by a pipe hung from the roof of the outlet tunnel. The rate of flow would be controlled by a valve at the rearing station. To insure a high dissolved oxygen content, an aerator would be provided at the rearing station.

Construction would take 4 years. The cut-and-cover conduit together with the control tower up to an elevation above the dry well floor level would be built first and used for diversion. The main dam construction would be carried on simultaneously with the spillway excavation, so that materials from the spillway could be placed in the dam without rehandling. Main coffer dams would be incorporated into the permanent structure.

Material to be excavated from the spillway will be shale in various stages of decomposition, most of which could be removed by ripping. Other fill materials will be excavated from valley bottom areas above the dam.

Concrete and road materials are available within reasonable trucking distance. A source of riprap is available 3 to 4 miles west of the site.

Qualified construction labor should be available within a reasonably close perimeter if work is forthcoming in the near future, from a group engaged in Interstate 64 and Gathright construction.

The area is within Appalachia where substantial unemployment exists. Since construction is usually one of the first industries to feel the effect of unemployment conditions, many of the presently unemployed may have construction experience. All of the unskilled and many of the semi-skilled workers would be recruited from the ranks of the unemployed and underemployed in Botetourt and adjacent counties. In addition, a number of qualified construction workers may also be recruited from the labor force of the nearby Roanoke Metropolitan Area.

13. RELOCATIONS AND ACCESS ROADS

There is no existing railroad within the limits of the proposed Hipes Reservoir. The Chesapeake and Ohio Railway line extending along Craig Creek has been abandoned and the rails have been removed. Some of the bridges still exist but are not in use.

Three State secondary highways would be affected by the reservoir and would require alterations. Virginia Highway 615 generally parallels Craig Creek throughout the reservoir site. Seven and one-half miles of this highway would be relocated above the level of the flood pool.

A number of State access roads from Virginia Highway 615 would be inundated by the proposed reservoir. Acquisition of lands bordering these roads would preclude the necessity for alteration or relocation.

Virginia Highway 606 would require about 1/2 mile of alterations. Also, Virginia Highway 612 would require a new bridge and about 1 mile of alteration.

A major access road from Route 615 would be constructed to provide access to the dam during construction and would provide access for operation after the dam is completed. This road would connect Route 615 with the dam and spillway and continue from the spillway to the stilling basin.

Two roads would be provided from Route 615 to the reservoir to assure proper operation, maintenance, and management of the reservoir. These roads would be located on the two peninsulas formed by the reservoir at Biggs Run and Schoolhouse Branch.

There are a number of rural power and telephone lines in the reservoir area which would have to be raised or relocated. There is also a small automatic telephone exchange belonging to the Roanoke-Botetourt Telephone Company which would have to be relocated. An estimated total of 300 graves are so located as to require relocation.

14. REAL ESTATE

The proposed reservoir would extend approximately 24 miles upstream along Craig Creek and lies in the northwesterly portion of Botetourt County (Fincastle Magisterial District) and the northeasterly portion of Craig County (Newcastle Magisterial District).

The tentative guide taking line for Hipes Reservoir has been established at elevation 1180 or 300 feet horizontally from elevation 1175, whichever encompasses the greater land area. The total land area required for the project is approximately 8,800 acres, including 1,076 acres for selected recreation areas situated above the guide taking line. All land is proposed to be acquired in fee simple. The taking includes 812 acres of Government-owned land in the Jefferson National Forest, which extends along the entire east side of the project and partially along the west side.

The project area consists of a relatively narrow, steep-walled valley, traversed by a serpentine stream. Approximately 30 percent of the reservoir area is cleared and the remainder is wooded. The woodland is cutover, with second growth stands of low merchantable value. The cleared land is for the most part of marginal quality and is devoted mainly to pasture, with some cropping for livestock feed production.

Improvements consist of modest farm sets and rural residences, two churches, a former school now used as a community center, two modest rural stores, and numerous summer-weekend type cabins.

Topography, access, and location are conducive to development of the area for recreational purposes, and it is in transition from agricultural uses to this purpose. A number of weekend cabins have been constructed on small waterfront sites in the past two years, and the two most recent farm sales appear to be for speculative purposes.

The community of Oriskany is located within the guide taking line. The community has no defined area but includes about 25 houses, 1 church, and a former school building now used as a community center. It has no separately owned streets, sidewalks, or utilities and has no governing body.

The gross appraised values are based on preliminary field inspection of the property involved, investigation and analysis of recent comparable sales in the vicinity, and data obtained from dealers, brokers, and officials in the area.

The taking would comprise all of the valley bottom from the steep mountain slope of the National Forest on the east side to the relocated state road on the west side, except for a small portion in the extreme upper reach, and little or no severance damages will accrue.

According to a recent Department of Interior, Bureau of Mines report, a small reserve of low grade iron ore is known to exist along the west side of the reservoir. Some iron ore was mined in the area during 1832 to 1925; however, no mining has taken place since that time. The report concludes that the inferior ore grade and cost of extraction negate any further profitable mining in the area. Titles were not abstracted, but it is believed that some second party mineral reservations may be affected by the taking. In view of the history and economic prospects, it is believed that acquisition cost of these rights, if any, would be neglible and within the contingency allowance.

There are 146 sets of occupied improvements in the taking, the owners and/or tenants of which would be entitled to reimbursement under Title 10, United States Code, Section 2680. The estimated cost of resettlement is included in the gross appraisal and is based on past experience.

15. RECREATION - THE CONCEPT EVOLUTION

The outdoor recreation planning concept for the proposed Hipes Reservoir evolved from an overall view of the project and its related environment. The visual dissimilarity of forested mountains and reservoir waters would provide an overview of unusual contrast. A compliation of various landscape patterns about the irregularly shaped body of water is enticing to the site designer as well as the intended visitor. As a result of natural and artificial visual barriers, accessibility, and singularity of form, nine sites on the reservoir are proposed for outdoor recreation development. Such development proposes high and low intensity use areas and simultaneously encourages the preservation and enhancement of an already existing quality environment. It is anticipated that a wide variety of recreation activities will be accommodated. These activities are (but not limited to):

Bicycling	Nature Walks
Boating	Outdoor Games and Sports
Camping	Picnicking
Driving for Pleasure	Sailing and Canoeing
Fishing	Sightseeing
Hiking	Swimming
Horseback Riding	Walking for Pleasure
Hunting	Water Skiing

Recreation - Environmental Influences - The Hipes Reservoir project comprises a northeasterly flowing portion of Craig Creek between Little and Rich Patch Mountains to the west and Patterson Mountain to the east. These mountains are a portion of the continuous linear ridges of the greater Valley and Ridge physiographic province. This province is in general a highly scenic region of the eastern United States. The rich landscape contrasts of high and low elevations in the project area are fine examples. Here, the alluvium and the protruding, resistant shales have formed folds or ridges which provide a series of vertical contrasts. These folds are particularly evident on the westerly slopes of Patterson Mountain.

Most of the project area is forested, especially the highlands, terraces and mountain tops. The Craig Creek Valley consists of an interspersion of mixed forests and farmland. About 30 percent of the reservoir area is cleared but is of marginal quality primarily the result of shallow soils. Most of this land consists of pasture; the remainder is devoted to livestock feed production. The reservoir area is for the most part in private ownership except for some small tracts of the U. S. Forest Service. It is interesting to note that there are nearly as many private camps and summer dwellings as there are rural family residences which indicate a trend away from agricultural pursuits toward a recreational environment.

The forest cover of the valley and highlands is certainly one of the leading characteristics in esthetic evaluation of the project area. U. S. Forest Service information states that the more common southern Appalachian hardwood types cover most of the lower and upper slopes of the mountains. Prominent hardwoods are scarlet, chestnut, white and red oak as well as cherry, birch, cucumber, maple and walnut. Slope and exposure apparently dictate the relinquishment of hardwood cover to conifers such as Virginia pine and pitch pine. A wide variety of shrubs, herbs, ferns and wildflowers common to the Appalachian Mountains may be found in the project area. Some of the common species of understory are mountain laurel, greenbrier, blueberry, dogwood, and persimmon.

With a preponderance of oak, conifer, and flowering shrub, the autumnal and vernal foilage display in the project area should be outstanding.

Wildlife habitat in the Craig Creek Valley consists of the mixed forest and farmland of the valley and the predominantly forested mountain slopes. Habitat values appear to be high on the Little Mountain slopes west of the proposed Hipes Reservoir. The steep face of Patterson Mountain to the east offers much less as wildlife habitat. Hunting pressure is reported to be moderate to high for whitetail deer, turkey, gray squirrel, and cottontail rabbit. Principal furbearers include beaver, mink, and muskrat. It is understood that the local population of black bear is increasing, and that bobcat are not uncommon in the area. At this writing, it is assumed that the small mammals and songbirds endemic to the southern Appalachian region occur in the Hipes project area. The occurrence of rare, recognized subspecies in small, unique areas such as "ecological islands" in the project area is presently unknown.

It is important to note that within about 8 miles south of the Hipes project, an interagency-supported Broad Run Cooperative Wildlife Research Area has been established. The results of studies conducted in this area should be vital to the wildlife management aspects of the nearby dam and reservoir project.

Craig Creek within the project area presently supports a warm water fishery consisting of small mouth bass, sunfishes, catfishes, and sucker. Trout compose the fishery of the upper reaches of Craig Creek. A detailed report on both the wildlife and fisheries aspects of the project area by the Bureau of Sport Fisheries and Wildlife is included in Appendix G.

The archaeological, historical, and natural history aspects of the Hipes project area have been evaluated by the National Park Service. Its report, which may be found in Appendix F, indicates that there are some archaeological and historical values in the project area. Evidence of both Archaic and Woodland occupations has been determined. Further study and investigation are required to reveal whether a village pattern

existed and to determine cultural relationships between the James and New River Basins. Historically, the economic livelihood of the project area was centered about the mining and production of iron ore from ferruginous sandstone. Today, the ruins of about seven mines or furnaces in the project area can be identified. Roaring Run Mine and Furnace located on Forest Service land five miles north of the Hipes damsite is probably the most important since it is in an excellent state of repair. It is concluded that there is sufficient archaeological and historical potential to warrant preservation and interpretation.

Present Recreation Opportunity - At the present time, the 20 miles of Craig Creek within the reservoir area as well as the 15 miles of stream below the dam support recreation oriented toward warm water fishing, hunting, picnicking, and summer home activities. No public access points have been provided on the 35 miles of stream; however, several private commercial sites are in existence. It is estimated that there are about 150 summer homes and hunting camps along Craig Creek from the reservoir area to the James River. A few of these homes have become permanent residences.

Data from the Bureau of Sport Fisheries and Wildlife indicates that the above 35 miles of stream support about 8,400 man days of fishing annually while total lands involved offer about 4,000 man days of hunting annually. In addition, it is estimated that about 30,000 annual recreation days may be attributed to activities centering about the summer homes and private recreation sites.

The higher elevations of the Craig Creek watershed are largely owned by the U. S. Forest Service and are within the jurisdiction of the New Castle District, Jefferson National Forest. Some camping, picnicking and hiking facilities have been provided. Scenery abounds on the Forest Service lands from forested mountain slopes to rushing streams and streamlets. However, these lands do not contain natural or artificial lakes suitable for water-oriented recreation development.

Recreation Market Area - The Bureau of Outdoor Recreation (BOR) defines the Recreation Market Area as that area from which 90 percent of the visitors to a project will be drawn on one-day outings and weekend (overnight) trips. The extent of the market area for the Hipes project is one hour's driving time of the reservoir (about 40 miles) with an appropriate portion of the population within 125 miles. The Bureau determined that nearly three-fourths of the expected participating population in the market area of Hipes (315,000) reside outside the Appalachian Region. Within one hour's driving time of the project are the standard metropolitan statistical areas of Roanoke and Lynchburg whose populations are expected to double by the year 2000.

Based upon the benchmark projections of population and income increases relative to participation in four key water-dependent or related

activities, the Bureau of Outdoor Recreation estimated gross demand in the market area at 7.4 million activity days in 1980. By the year 2020, some 19.1 million activity days are expected (See Recreation and Aesthetics, Appendix F).

An evaluation of the non-urban outdoor recreation supply within the market area utilized both existing areas and those potential areas expected to be available by 1980. Considering opportunities afforded by the Jefferson and George Washington National Forests, water resource projects such as Smith Mountain Reservoir and Gathright Reservoir, and various state parks in the market area, the Bureau concluded that about 13,000 acres of impounded water suitable for the key activities would be available by 1980. Also, about 640,000 acres of land (mostly the National Forests) would be available by 1980. Exhibit 4-28 portrays the existing recreation sites and areas within a 50-mile radius (approximately the BOR's market area) of Hipes Reservoir. In addition, an overview of existing recreation sites and areas are displayed for the area just outside the market area within the zone of influence.

The Bureau's analysis of recreation demand and supply determined that there is a present need to provide lands and waters for water-based outdoor recreation opportunity. The proposed developments known at this time are not expected to satisfy the future demand.

The proposed Hipes Reservoir can supply about 4,500 surface acres of recreation water in a strategic location within the Jefferson National Forest. More importantly, developable lands adjacent to the reservoir exhibit an excellent potential to accommodate the key activities (boating, camping, picnicking, and swimming) cited by BOR.

The following formula, developed by Messrs. Duck, Beard, and Rath of the Ohio River Division, U. S. Army Corps of Engineers, and presented in Technical Paper No. 4, "A Simplified Method for Deriving Cost Estimates for Recreation Survey Scope Investigations," was used in determining the initial and ultimate daily attendance for general recreation:

$$DL = \frac{\frac{A \times 70\%}{13}}{2.0} \times 40\%$$

Where:

DL = Design Load = the number of people expected to use a project or facility at any one time on a normal summer Sunday.

A = Estimated annual attendance 300,000 initial and 925,000 ultimate.

70% = Percent of attendance that will visit project during recreation season.

13 = Number of weeks in recreation season.

40% = Percent of weekly attendance expected on a normal Sunday.

2.0 = Turnover rate of use of facility.

A brief description of possible key recreation sites follows. The locations are shown on Exhibit 4-29. The plan of development for each of these sites was initially developed by the Norfolk District, Corps of Engineers, and furnished the National Forest Service for review and comment. Adjustments to individual site developments were made on the basis of comments and suggestions of the National Forest Service. This procedure was adopted since the entire project is within the Jefferson National Forest boundary and since it is anticipated that the Forest Service will manage the intial development.

In addition to the initial development in the areas described below, the Forest Service will identify and develop other sites within the taking line as necessary to satisfy the demand.

Hipes Dam and Reservoir Operation Headquarters (Site 1) - The Hipes damsite is about 15 miles upstream from the confluence of Craig Creek with the James River near Eagle Rock, Virginia. The site is located in a narrow valley section, at a heavily wooded bend in the creek. The creek sides rise abruptly from the streambed at elevation 1013 msl. The right bank continues to rise almost vertically to the 2000-foot pinnacle of Patterson Mountain just below the dam. The dam and spillway area is expected to attract a substantial number of visitors, not only to observe the appurtenant structural features, but also to view the impoundment behind the dam as well as the stream course below. For many, the headquarters area would provide the first opportunity to view Hipes Reservoir in its highly attractive setting. A 100-acre wooded site along the left bank adjacent to the dam is proposed to accommodate visitors to the dam and reservoir operation headquarters. In addition to parking areas near the dam, facilities for picnicking, walking, and sightseeing would be provided. It is also planned to provide interpretive stations dealing with the various engineering aspects of project design and operation.

Lemon Branch Marina (Site 2) - This marina is proposed for a large, protective cove near the damsite. In addition to its attributes for the development of boating facilities, the Lemon Branch site is backdropped by the scenic ascent of Rich Patch Mountain and the Jefferson National Forest. The site also offers advantages for project operation and management since its location on the primary access road near the dam would serve to "draw off" a substantial volume of recreation traffic. The 50-acre Lemon Branch site would be the principal boating area on Hipes Reservoir. Facilities would be provided for a marina complex offering permanent and temporary mooring, boat launching, fuels and repairs, fishing supplies, and food service. Complementary facilities such as walkways and rest areas could also be provided. On the main body of the reservoir adjacent to the marina, there would be a potential beach area which could offer opportunity for swimming. Further study is necessary to determine the feasibility of this area to provide a swim beach with attendant change houses, parking (if necessary), and concession facilities. It is anticipated that the facilities planned at the Lemon Branch Marina would be provided by private enterprise through concession contract.

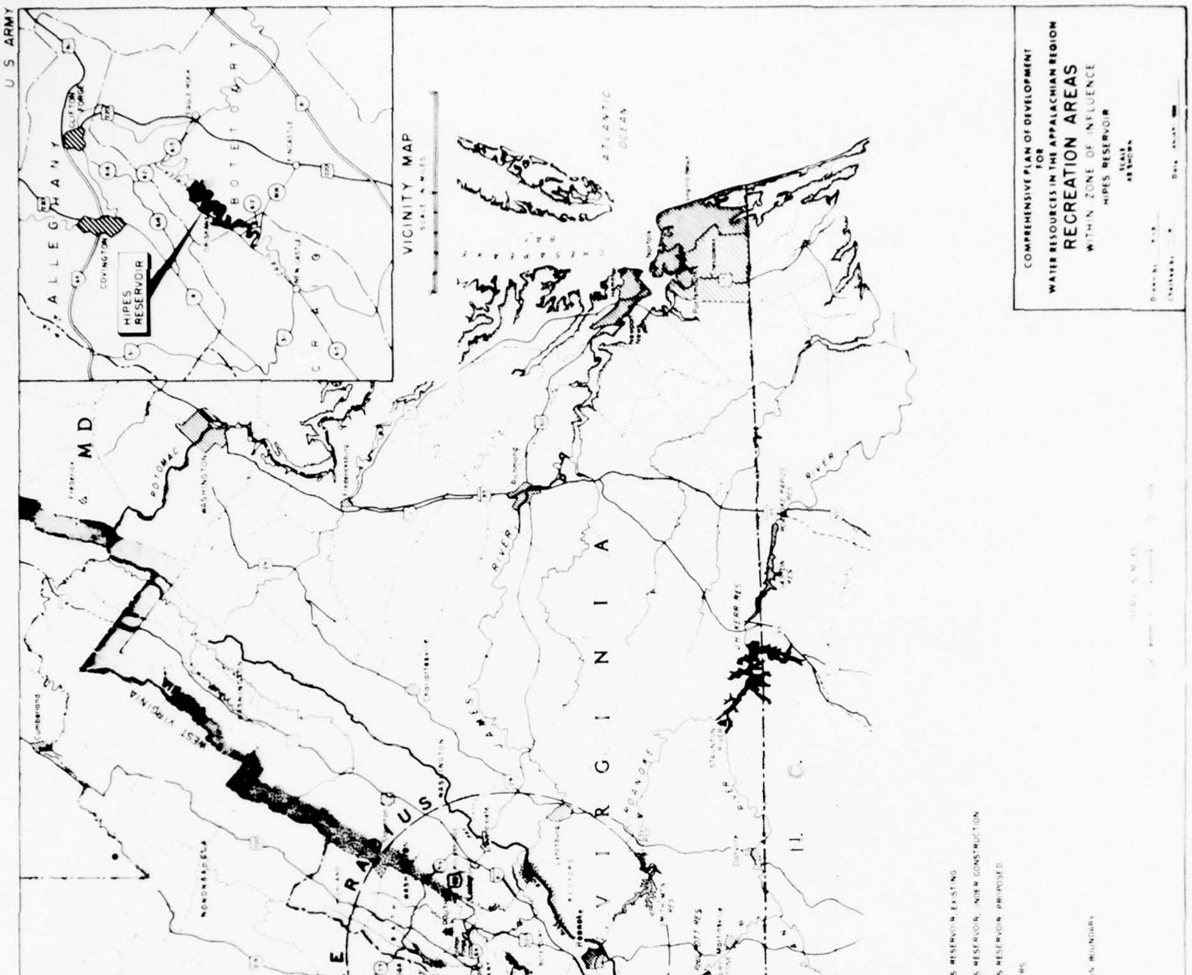
COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION
RECREATION AREAS
WITHIN ZONE OF INFLUENCE
HIPES RESERVOIR
CORPS OF ENGINEERS
U S ARMY
VICINITY MAP
HIPES RESERVOIR
COVINGTON
ALLEGHANY
BOTETOURT
CRAIG
50 MILE RADIUS
OHIO
KY
W VA
MD
VIRGINIA
N. C.
ATLANTIC OCEAN
POTOMAC
JAMES RIVER
ROANOKE
SUTTON RES
SUMMERSVILLE RES
BLUESTONE RES
GATHRIGHT RES
WASHINGTON
LEGEND
CORPS OF ENGINEERS RESERVOIR EXISTING
CORPS OF ENGINEERS RESERVOIR UNDER CONSTRUCTION
CORPS OF ENGINEERS RESERVOIR PROPOSED
RESERVOIR BY OTHERS
STATE PARK
NATIONAL FOREST
APPALACHIAN REGION BOUNDARY

Exhibit 4-28

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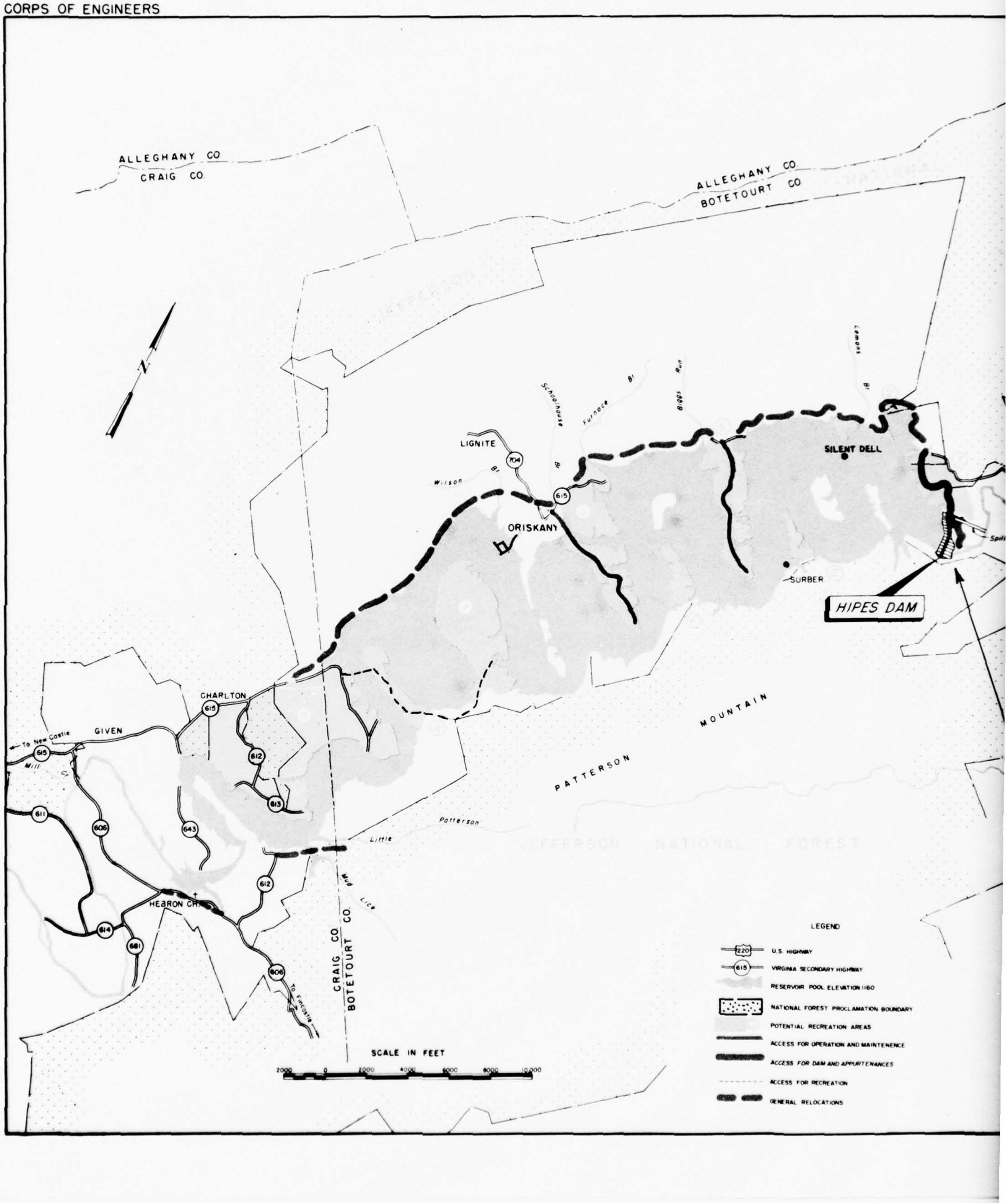
CORPS OF ENGINEERS



U.S. ARMY

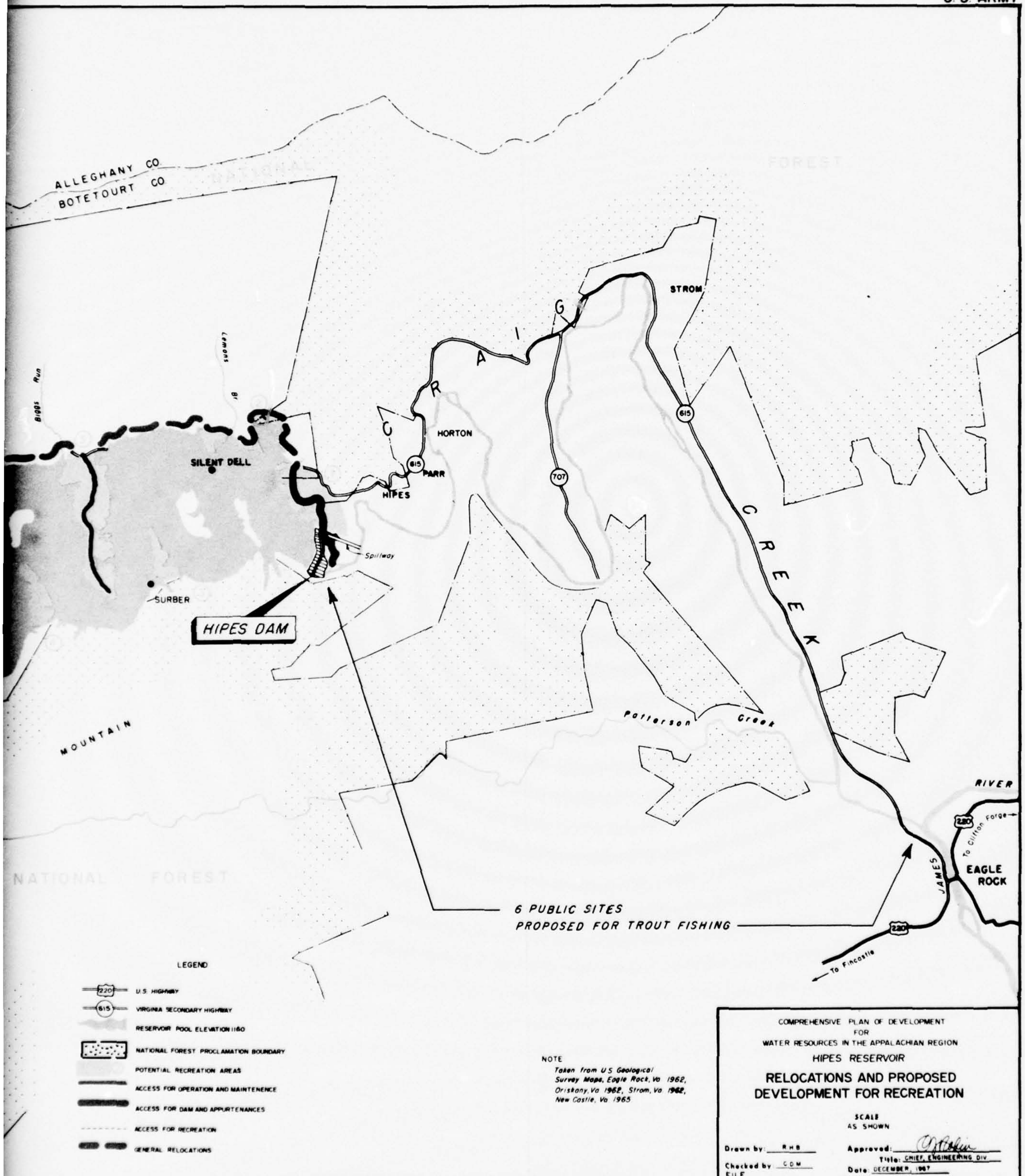


Exhibit 4-29

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Surber and McKalester Camping Areas (Sites 3 and 4) - Surber and McKalester Camping Area sites are situated on the southeast (right bank) of the reservoir and contain 40 and 70 acres respectively. Both sites are narrow peninsulas sharing in common the backdrop of scenic Patterson Mountain, a forward view of a large expanse of the reservoir, and access by boat only. The rugged and heavily wooded character of the peninsulas suggested limited development for boat camping. A near primitive experience for the camper could be thus attained. Development would include marked campsites, boat beaching areas, and sanitary facilities. A limited system of foot trails on the Surber and McKalester Areas would add materially to the outdoor experience.

Biggs Run Recreation Area (Site 5) - Biggs Run Recreation Area would be on a large peninsula jutting into the reservoir from the left bank. The long steep-sided ridge would nearly bisect the reservoir. From the developable surface of the 200-acre peninsula the visitor would be offered a maximum of visual contrast. Behind him would be the expanse of Rich Patch Mountain; his frontal view would encompass the impressive folds and crests of Patterson Mountain; on either side, there would be a broad area of reservoir waters whose visual surface is enhanced by wooded islands. It is proposed to develop the Biggs Run Area for picnicking and camping. Facilities for picnicking would include some small shelters as well as individual sites; camping facilities would include both tent and trailer sites with a play apparatus area and a small, open community center. A loop of foot trails about the perimeter of the peninsula would add materially to a visitor's experience. The Biggs Run Area was once heavily wooded, but a present timber cutting operation has been detrimental to the site. The early institution of forest management practices on the site would prove invaluable for subsequent recreation development and site planning.

Schoolhouse Branch Recreation Area (Site 6) - Schoolhouse Branch Recreation Area is similar in most respects to the Biggs Run Area. It would be a large peninsula bisected by the Schoolhouse Branch of Craig Creek. The outer half of the 260-acre site would actually be a large island. The Schoolhouse Branch Recreation Area is one of the most scenic sites at the Hipes project. It enjoys essentially the same visual contrast amenities as the Biggs Run Area, but contains the additional assets of substantial forest cover and variety in pattern provided by the outer island. It is proposed to develop the island portion of the Schoolhouse Branch Area as the principal tent and trailer camping site of the Hipes project. Campsites would be clustered about loops off the main road. Play apparatus areas and a community center would also be provided. Access to the island would be gained over a bridge and extension of State Secondary Highway 615. The inland portion of the Schoolhouse Branch Area would be developed for picnicking which would include individual sites, shelters, and a small playfield. Foot trails with overlooks and nature interpretive stations are proposed for both the camping and picnicking sites. A major service facility on or near Route 615 should be considered to provide fuel, supplies, first-aid, and communications for visitors utilizing the Schoolhouse Branch Area. The service area could also contain a recreation maintenance yard.

Oriskany Recreation Area (Site 7) - Oriskany Recreation Area would be the principal day-use activity center of the Hipes project. This 340-acre site would be a peninsula from the right bank and, like the preceding areas, offers a maximum of visual contrast. In addition, it is a large area topographically suitable for intensive day-use development. About 80 percent of the area is covered by more mature hardwoods and conifers. It is anticipated that development of the Oriskany Area may be accomplished with minimum disturbance to this attractive forest cover. The large extent of open lands offers an unusual opportunity for landscape planting and facility design in association with the various recreation activities. Access to the Oriskany Area would be via a project road and bridge over a narrow portion of the upper pool. A distinct advantage would be gained by this spur off Route 615 in that traffic to an impact area from the upper reservoir would be funneled away from the primary access road. Also, a bridge crossing the upper pool would minimize possible interference with recreation boat traffic. Development of the Oriskany Recreation Area would feature swimming, picnicking, and outdoor games and sports. Facilities for the swimmer would include a beach, diving platforms, change houses, concession and lunch area. Picnicking facilities would include individual sites and several large group shelters. Games and sports areas would include facilities for tennis, softball, badminton, archery, bicycling, and non-motor boating. Foot trails and nature interpretive sites should also be included. An arts and crafts shelter could be included not only for young people, but also for elderly and handicapped persons as well. Specially designed walkways with rest points could also be considered for the non-ambulant person. The picnic and sports areas should be serviced by a major concessionaire who would also provide the special day-use facilities. An appropriate maintenance center should be planned for the Oriskany Area.

Crawford Recreation Area (Site 8) - Crawford Recreation Area is a narrow wooded ridge which would become a peninsula on the right bank of Hipes Reservoir toward the upper end of the pool. The project road between primary access Route 615 and the Oriskany Recreation Area runs nearly the entire length of this 80-acre peninsula. A drive through the Crawford Area would offer the visitor such contrasting landscapes as Little Mountain, Patterson Mountain, the tall forest cover of the Oriskany site, and an expanse of downstream reservoir waters, replete with a wooded island. The Crawford Area has the misfortune of location where reservoir drawdown could affect the quality of the outdoor experience at the site. In consideration of drawdown, recreation development should be minimal consisting of rest stops or turnouts with some individual picnicking facilities. Perimeter foot trails should also be developed. According to the frequency curves, severe drawdown may be expected less than 20 percent of the time over 40 years. As such, it is recommended that the Crawford Area be designated as an overflow camping area and as a rotation camping area to relieve other sites.

Craig Recreation Area (Site 9) - Craig Recreation Area is the largest individual site on Hipes Reservoir. This 910-acre tract on the left bank

would be the most distant site planned for development upstream from the dam. The Craig Area is largely wooded, irregularly shaped, and distinctly variable in topography and slope. It would lack the significance of an adjacent large pool area; nevertheless it is supported by commanding views of Little and Patterson Mountains. Since the Craig Area is located at the upper end of the reservoir, the effects of drawdown may pose serious development problems as well as to create, periodically, an unattractive shoreline. A group camping area is proposed for a small portion of the site. Such a development would provide opportunity for natural science education as well as active recreation pursuits. Group camp facilities would include shelters and tenting sites with a central lecture and dining hall. Active demonstration projects could be prepared to acquaint participants with the study of conservation and provide an opportunity to actively engage in its practices. A small playfield and beach for the group campers should be provided. The feasibility of a beach requires further study in view of drawdown; however, it appears that with little or no drawdown 50 percent of the time, such a facility is warranted. By size alone, the Craig Area assumes major importance for possible wildlife demonstration programs and for future development based upon possible changes in public recreation desires.

Optimum Development Considerations - The preceding discussion treated in some detail each site selected for outdoor recreation development. However, project lands and waters as well as adjacent lands would offer additional potential opportunities.

a. Roads Required - Interstate Highways 64 and 81 follow routes passing about 15 miles to the north and east of the project site, providing access from the more distant population centers of Washington, D. C., and Richmond, Va., as shown on Exhibit 4-1. U. S. Highway 220 connects with the interstate routes and U. S. Highway 60 and passes through Fincastle and Eagle Rock. Access to the head of the proposed reservoir from Fincastle would be via State Secondary Route 606. State Secondary Route 615 connects with U. S. Highway 220 at Eagle Rock and would provide access to the downstream trout fishery, the trout rearing station, and the reservoir area recreation development. From Route 615, the operation and maintenance roads at Biggs Run and Schoolhouse Branch would convey visitors to various recreation facilities within the major developed sites on the left bank of the project. In addition, a major recreation access road would be provided to the Crawford and Oriskany areas from Route 615. A network of circulation roads and parking areas would be provided for access to the individual recreation facilities. Routes 606 and 615 are hard surfaced, but narrow and winding, and should be improved by the Commonwealth of Virginia where unaffected by relocations. The access roads are shown on Exhibit 4-29.

b. Trails - At the present time, there are several trails on lands of the Jefferson National Forest adjacent to the Hipes Reservoir project. Wherever feasible, these trails could be extended to recreation areas on the project with minimal ingress on private lands. The 2,000 mile Appalachian Trail passes about 20 miles southwest of Hipes Dam. This highly

significant route has been recommended as a National Scenic Trail by the Bureau of Outdoor Recreation.*/ An existing trail on the National Forest over North Mountain nearly links the damsite to the Appalachian Trail. To complete the linkage, a short spur would be required from the Craig-Roanoke County line to the Appalachian Trail, and a new but short trail addition would be required across Patterson Mountain to the dam. In either case, the linkage could take place on Forest Service lands. Several shelters should be provided on the spur between the Appalachian Trail and Hipes Dam.

c. Scenic Road - It was suggested by the U. S. Forest Service that a scenic road be considered on the heights around the Hipes project. Preliminary route location and cost data were studied, but no specific recommendations were obtainable. A subsequent field review of the project area by an interagency group reached the conclusion that (1) road construction on the highly scenic and rugged Patterson Mountain (right bank) would unduly impair its esthetic value, and (2) improvement of an existing road atop Bald Mountain (left bank) might be feasible. This route offered views of mountains as far away as West Virginia as well as a lofty perspective of the Hipes Reservoir. Representatives of the Forest Service, Bureau of Outdoor Recreation, Corps of Engineers, and Commonwealth of Virginia agreed that the Bald Mountain road was the likely alternative and that a scenic road study in depth need not be made at this time.

d. Winter Activities - There exists a potential to provide some opportunity for winter recreation activities. At this time, no specific sites or developments are proposed for this purpose. However, some of the preceding developments could function to serve winter visitors. Further study is needed to determine the feasibility of operating and maintaining the recreation complex where specific winter activities are wholely dependent upon snowfall, duration of the snowpack and ice formation.

e. Land Required - The land to be developed for recreation is shown on Exhibit 4-29. The optimum annual capacity of the proposed reservoir area was estimated at 925,000 visitor-days by the Bureau of Outdoor Recreation for a conservation pool at 1160 msl. Recreation values should be assured permanence by the acquisition in fee of sufficient land to buffer recreation areas and to preclude adverse land use. Adequate land for future as well as initial recreation development should be acquired initially in order to control the development, to prevent overcrowding and to avoid possible price escalation. These lands for project and recreation purposes are considered necessary and sufficient to meet the requirements of Senate Document No. 97, dated 29 May 1962, which recommends appropriate public acquisition of lands and rights-of-way adjacent to proposed Federal water resource projects to insure full ultimate realization of the outdoor recreational opportunities.

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*/ TRAILS FOR AMERICA, Bureau of Outdoor Recreation, U. S. Department of Interior, 1966, 166 pp.

The reservoir lies within the boundaries of the Jefferson National Forest. However, the majority of lands in the valley floor and some high land on the left bank are in private ownership.

f. Archaeological, Historical, and Natural History Interpretation - Data from the National Park Service indicates that the Hipes project area merits the inclusion of interpretive facilities in a final plan. Details of any interpretive, preservation, or salvage plan will be worked out with the National Park Service and U. S. Forest Service at a later date.

Scale of Recreation Development - The Hipes Dam and Reservoir project is currently being evaluated under Section 206 of the Appalachian Regional Development Act of 1965, PL 89-4. Major emphasis has been placed upon identifying opportunities for investments in areas displaying significant potential for future growth, and where the return on public dollars invested will be the greatest. A preceding section discussed the greater regional aspect of recreation attractions and the likelihood of economic growth arising therefrom. Undoubtedly, the Hipes project recreation plan will contribute to the local economy through employment and visitor services. However, in most circumstances, the extent of community economic support will largely be determined by the attractiveness of the project to entice longer-staying visitors. Seldom can this be done without local support in planning complementary facilities and services. One of the better ways to catalyze economic growth through recreation, with less public funds invested, is to provide an atmosphere conducive to private investment. Most such recreation enterprises feature a high intensity use complex centered about an overnight lodge, e.g., golf complex, boatel-marina sites, winter sports lodges, and hunting-fishing-shooting sports complexes. Restaurants, theatres, shops, and outdoor amphitheaters are often included with privately supported high-intensity use areas. It is believed that the quality and extent of the Hipes project would attract private investment in one or more of the lodge-type complexes provided such an investment opportunity was made available.

Beautification Aspects - As detailed planning progresses, a prime consideration will be to gain the optimum in recreation development without appreciable detriment to the natural beauty of the area. The relocation of Route 615, which would function as the primary access in the reservoir area, would be located to best fit the topography and aligned to capitalize on exceptional views in the area. A minimum buffer strip of 300 feet would be maintained between the reservoir and the road; however, some tree thinning and clearing would occur where vistas are desired. Circulation roads within proposed recreation areas would be constructed as close to existing grade as possible to curtail excessive earthwork and consequential scarring. Proper erosion control methods would be utilized, where necessary, to stabilize highway slopes as well as stripped areas in the dam and spillway area.

There is evidence of some commercial tree cutting in the proposed reservoir area which has depleted many of the desired mature tree species. Two of the proposed Recreation Areas, Biggs Run and Oriskany, have only partial tree cover. Major tree planting programs are planned for these areas, and where needed, the institution of silvicultural practices is proposed for areas which have undergone commercial cutting. Rapid-growing, indigenous species such as native pine, red maple, and tulip poplar will be used primarily.

Wildlife Considerations - A detailed report on wildlife aspects of the proposed Hipes Dam and Reservoir has been prepared by the Bureau of Sport Fisheries and Wildlife and is contained in Appendix G. Briefly, the Bureau indicates that significant losses to bottomland wildlife habitat will occur as a result of the impoundment. This loss is expected to affect wildlife resources of the adjacent uplands since, to a degree, the bottomlands are utilized for food and sanctuary especially by deer, turkey, and ruffed grouse.

To a certain extent, losses in wildlife habitat correspond to similar losses of hunting opportunity, provided most of these lands were open to public hunting. At the present time, hunting pressure is reported to be moderate to high in the Craig Creek area. The Bureau of Sport Fisheries and Wildlife estimates that, as a result of the conservation pool and partial inundation of uplands by the flood pool, 2,100 hunter days annually would be lost over the life of the project.

Most of the land areas of the project will consist of uncultivated, forested uplands which are required for development of general recreation facilities. Adjacent lands are largely steep mountainsides unsuitable for wildlife habitat. The Bureau of Sport Fisheries and Wildlife indicates that waterfowl habitat provided by the reservoir will be of poor quality. The impoundment will largely serve as a resting area for migrating fowl.

Consideration was given to acquisition of lands for the specific purpose of mitigating hunting opportunity losses. However, available lands were determined to be unsuitable because of steep land slopes or unproductive shaley soils, or both. Therefore it became apparent that the only feasible method of offsetting the hunting opportunity loss would be to increase the wildlife population of the proposed recreation areas and the adjacent Jefferson National Forest through establishment of food crops and favorable habitat.

It is believed that the Craig Recreation Area (Site 9) would offer potential for wildlife management. Small food plots and forest management practices favoring game birds and animals would assist in providing opportunity for hunting. Other sites would be utilized where possible depending upon visitor safety factors and needs to accommodate late season visitors. Some project roads could offer access for hunters to nearby hunting sites in the Jefferson National Forest.

It is possible that arrangements could be made with the Forest Service to develop wildlife lands in the Jefferson National Forest for both habitat and hunting opportunity. The newly established Broad Run Cooperative Wildlife Research Area 8 miles south of the Hipes Dam should play an important role in this regard as well as the wildlife management aspects of the reservoir project itself.

Reservoir Fishery - Details of the fishery aspects of the Hipes project may be found in Appendix G prepared by the Bureau of Sport Fisheries and Wildlife. The Bureau reports that current fishing pressure on the portion of Craig Creek that would be flooded by the reservoir is moderate to high for coldwater species such as trout. The subsequent loss of the stream fishery would be replaced by a much greater warm water habitat area which would offer smallmouth and largemouth bass, rock bass, sunfishes, catfishes, walleye pike, and crappie. The Bureau has also included trout as a possible reservoir species.

It is anticipated that the Virginia Commission of Game and Inland Fisheries would develop and maintain a fishery management plan for the reservoir. Initial costs to establish the reservoir fishery have been estimated at $37,000. This cost would not be subject to participation by non-Federal interests.

Reservoir access sites and boat launching facilities for fishermen are included in the general recreation plan. Service facilities for fishermen will be provided on the project and are expected to be available in nearby communities.

A reservoir zoning plan is recommended to provide as much "quiet water" as possible for shore and boat fishermen.

Associated Project Development

Trout Rearing Station - The Virginia Commission of Game and Inland Fisheries has indicated a preference for a cold water fishery to be established on Craig Creek below the proposed Hipes Dam. This proposal utilizes a potential asset of the project which is a supply of cold water available in the lower portions of the reservoir. The Commission also recommends that a trout rearing station accompany the cold water fishery as a significant enhancement feature of the Hipes project. Recent surveys in western Virginia failed to disclose a more desirable source possessing the quantity and quality of water needed to establish a facility for rearing fingerling and adult trout. Fish reared at the Hipes project would be stocked in Craig Creek and other streams as well. It was reported that the Hipes rearing station would have a production of 75,000 pounds of trout (mostly rainbow) annually of which at least 6,000 pounds would be allotted to Craig Creek.

The trout rearing station would have two firm requirements, a dependable source of water at suitable temperatures, and adequate lands available for buildings and raceways. It was determined that both requirements could be met. A continuous flow of 20 cfs from the reservoir will pass through separate outlets in the intake tower which will permit the release of suitable mixture of cold water from the bottom of the reservoir and surface water containing dissolved oxygen from the top of the reservoir. Incoming water to the rearing station will be about 60 degrees F. Ten raceways, 200 feet by 10 feet, are planned. Prior to entering the raceways, incoming water will be passed by free-fall over a series of baffles to provide additional aeration. Water passing through the rearing station will be returned to the stream.

In addition to the buildings, structures, and appurtenances required for the rearing station, it is also planned to provide an interpretive center and parking facilities to accommodate visitors to the trout rearing facility. Total land requirements for the rearing station would be about 20 acres. A schematic drawing of the proposed rearing station appears in Exhibit 4-30.

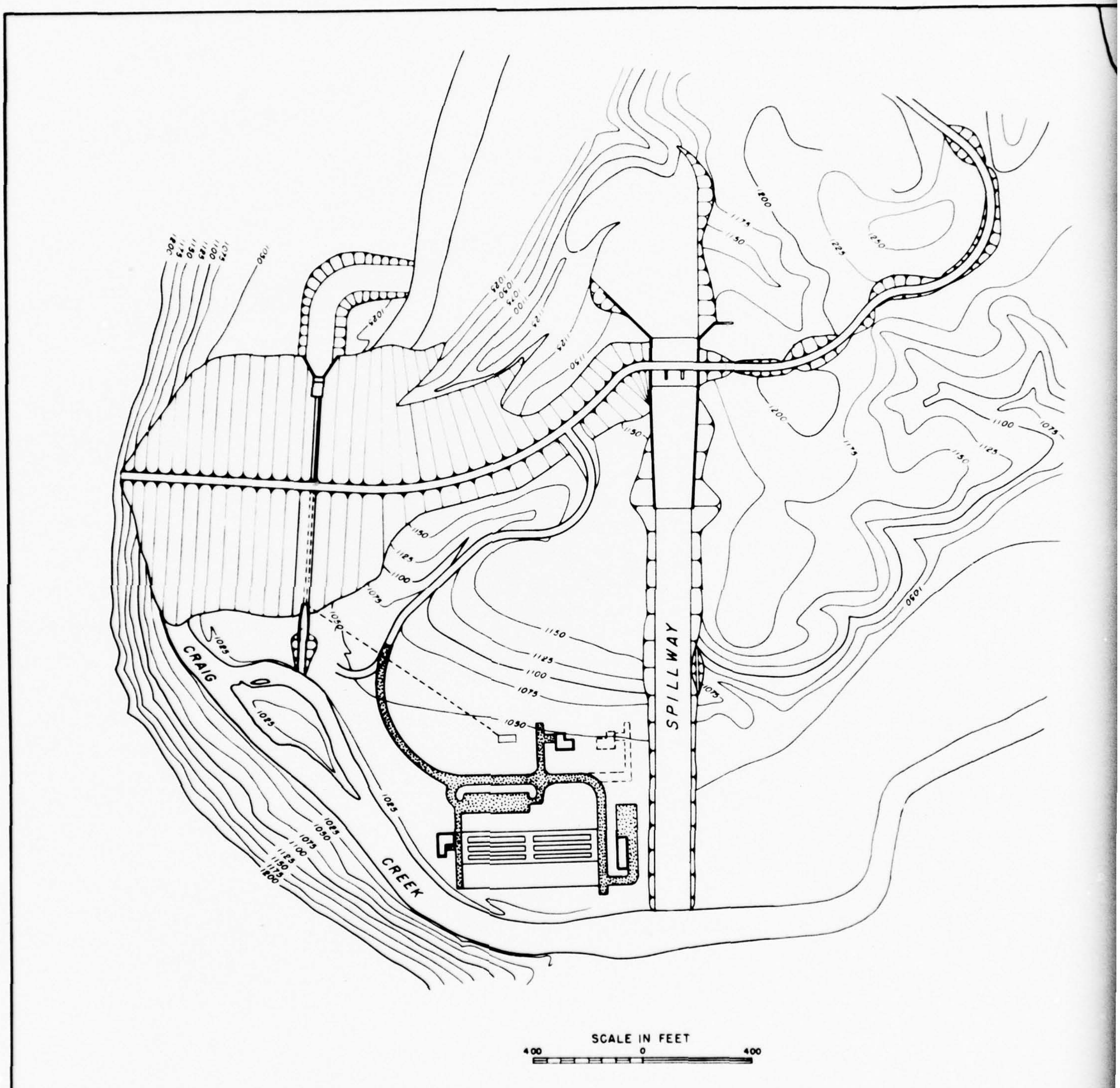
Downstream Fishery - Lowering of the temperatures of Craig Creek below the damsite, due to releases through the conduit to evacuate the flood control pool, and for water quality control, would destroy the existing warm water fishery. To offset this loss, and to realize the full recreational potential created by the temperature control provided by the project, development of the downstream cold water fishery is proposed.

The establishment of a cold water fishery for the 14.8 miles of Craig Creek below the proposed Hipes Dam represents an additional enhancement feature of the overall project. With a suitable mixture of cold water and dissolved oxygen being supplied from the multiple-level intake tower at the dam, it is believed that Craig Creek would become one of Virginia's outstanding stocked trout streams.

In order to achieve the desired development of Craig Creek as a cold water fishery, two principal requirements would have to be met, (1) public access to the stream between the damsite and confluence with the James River, and (2) adequate parking areas adjacent to the stream.

At the present time, there are no public access points on Craig Creek below the proposed dam. To provide for such access and parking, six sites of about two acres each have been suggested (See Exhibit 4-29). It is planned that 3 of these sites would offer boat launching and sanitary facilities. All sites will provide parking and access roads thereto. The estimated costs to acquire and develop the six sites are presented in Section IV of this chapter.

A most important aspect of the downstream cold water fishery is the assurance of sufficient right of way to enable fishermen in the pursuit



CRAIG
CREEK
SPILLWAY
SCALE IN FEET
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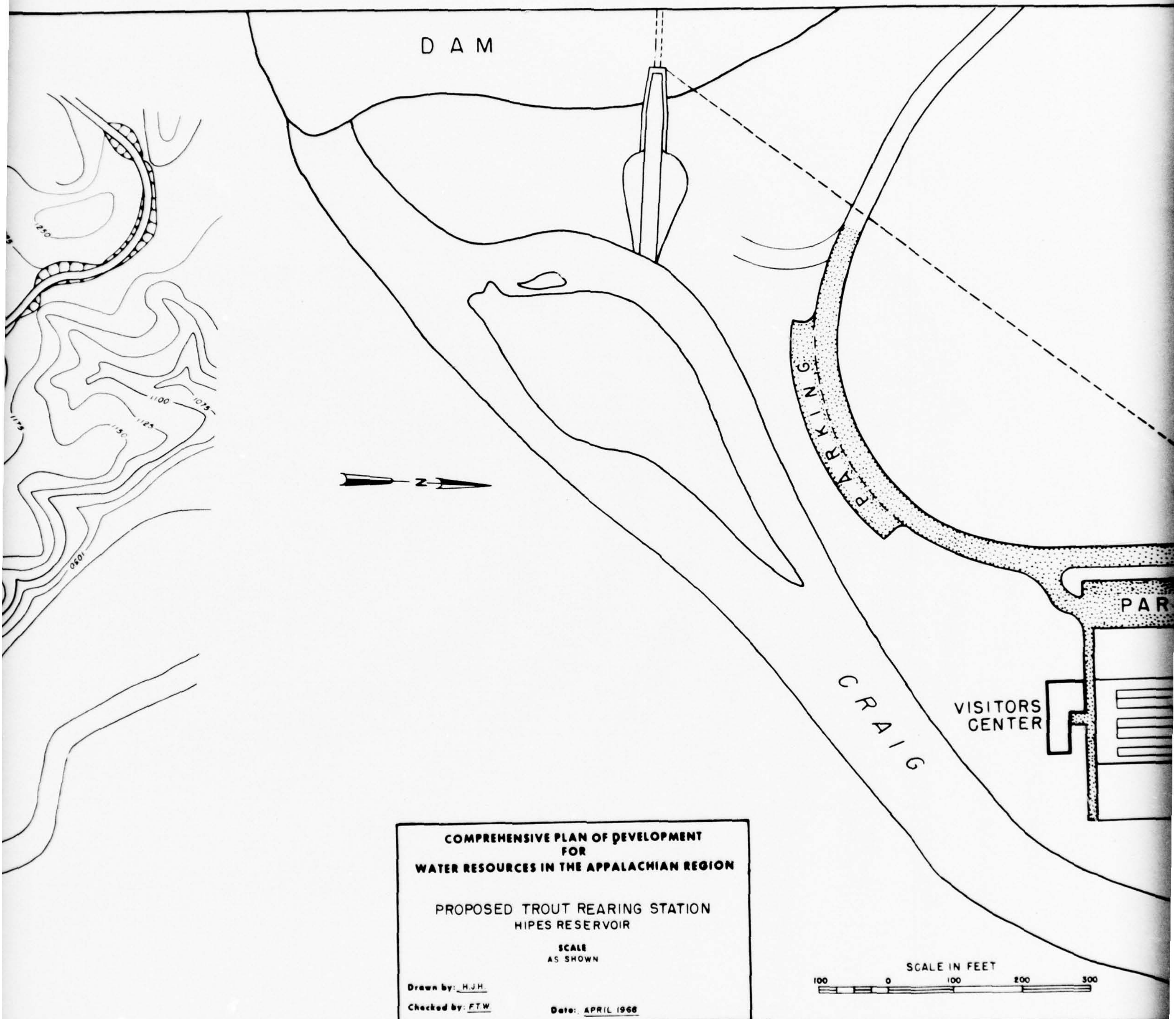
2



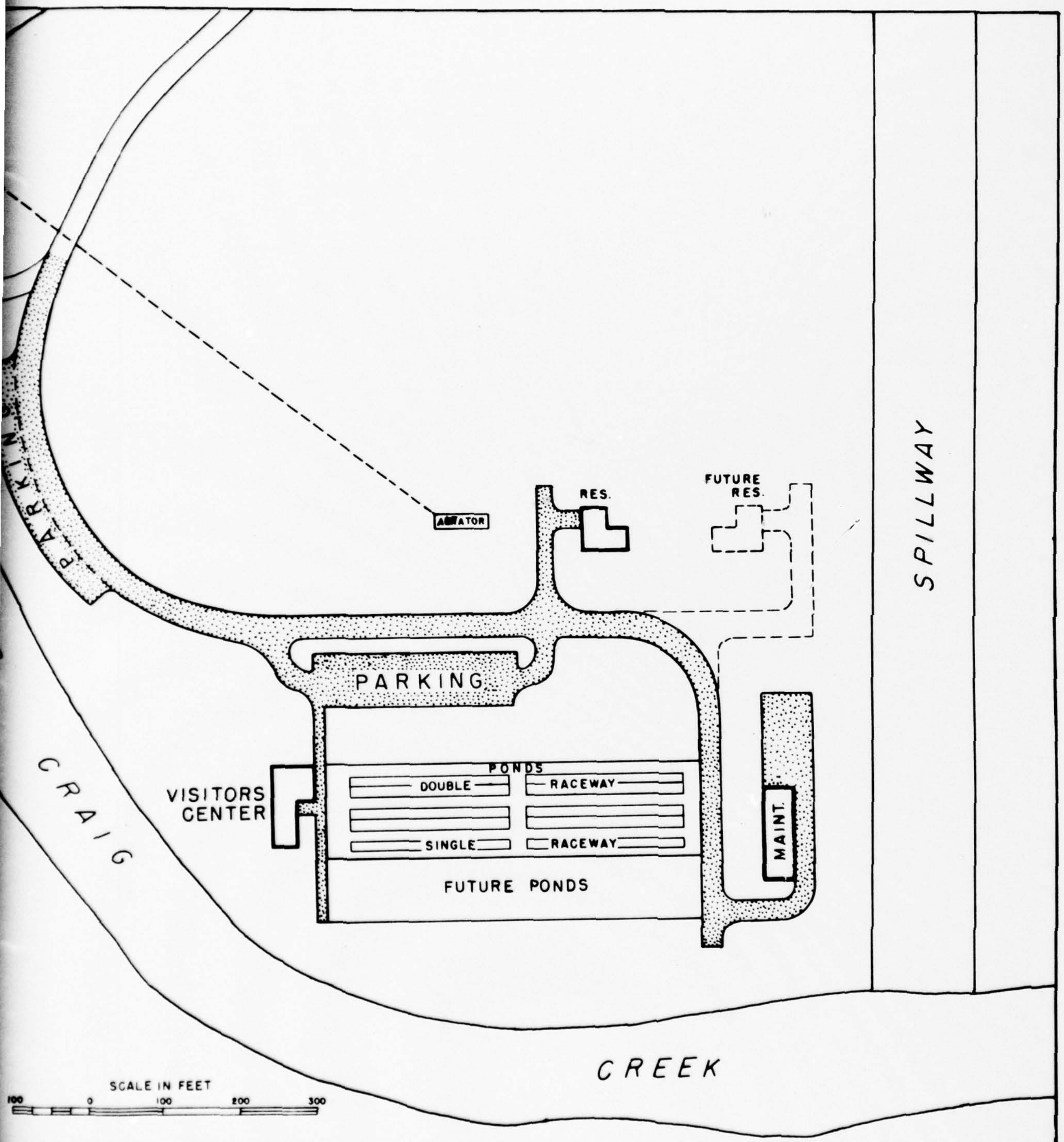
COMPREHENSIVE PLAN OF DEVELOPMENT FOR WATER RESOURCES IN THE APPALACHIAN REGION

PROPOSED TROUT REARING STATION
HIPES RESERVOIR

SCALE
AS SHOWN

Drawn by: H.J.H.
Checked by: F.T.W.
Date: APRIL 1968

FILE: GG006E-0


PARKING
RES.
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SPILLWAY
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SINGLE
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VISITORS CENTER
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SCALE IN FEET
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300

Exhibit 4-30

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of fish to walk along, wade, or boat the stream between the six suggested access sites. After considerable study, it was concluded that public right of commerce up to the ordinary high water mark would constitute sufficient accessibility; however, such rights could only be claimed if Craig Creek was declared a navigable stream. After viewing several stream reaches, a general definition of the ordinary high water mark was proposed as that point on the stream banks displaying a permanent mark of normal high streamflow throughout a series of years excluding flood conditions. The mark was visualized as the breakoff of stream banks, the permanent streamside tree line, or a gravel bar or flat which is covered by water during some periods of a year. Access according to this definition was deemed the minimum required. In the event that judicial opinion would place the ordinary high water mark below that envisioned, it is proposed that the difference be acquired. Thus, should Craig Creek be declared non-navigable, it would also be proposed to acquire streambed lands up to the mark described above. The estimated cost of this acquisition is presented in Section IV.

Another aspect of the cold water fishery proposal for Craig Creek is water quality. At the present time, standards have not been officially adopted for Craig Creek; however, the state standards considered envision a warm water environment for the stream. A standard which would be appropriate for cold water environment would include temperatures not to exceed 68 degrees F., no less than 5 ppm of dissolved oxygen, and a pH of 6.5. In view of the many summer homes and hunting camps presently on Craig Creek and the likelihood of many more to be developed in the future, it appears that appropriate water quality standards and sanitation codes should be considered by local authority prior to the establishment of the fishery and further development of summer homes.

<u>Problem Orientation</u> - The proposals contained in the preceding paragraphs are believed to represent maximization of water resource benefits for the project and associated development on Craig Creek. However, for the purposes of planning, it is well to identify at least some of the problems which may befall effectuation of the proposals.

The warm water fishery of the reservoir should provide high quality opportunity for the angler. The effects of reservoir drawdown upon the fishery are not known at the present time. Perhaps the most significant effect would be on fisherman access to the waters. However, it is believed that access can be obtained for boat fishermen during most of the major recreation season. Access for bank fishermen may be curtailed somewhat especially in the extreme upper limit of the reservoir.

Perhaps the major problem that could beset the trout rearing station would be a curtailed supply of cold water in the summer during periods of heavy, warm rains after reservoir stratification. Studies by the Bureau of Sports Fisheries and Wildlife indicate that there is sufficient cold

water storage capacity in the reservoir to offset this problem. Nevertheless, strict adherence to a monitoring schedule should be maintained.

Environmental problems may occur on Craig Creek when that stream is changed from a warm water to a cold water habitat. Once again, the problem of a warming trend in the summer may occur. Both the Bureau of Sport Fisheries and Wildlife and the Virginia Commission of Game and Inland Fisheries believe that excessive warming of waters in the 15-mile segment of Craig Creek below the dam will not occur often enough to be detrimental to the entire trout population stocked in the stream. This thesis is supported in the 50- to 60-mile segment of the White River below Table Rock Dam, Missouri, where a similar cold water fishery has been established.

Another problem entertains the question of whether a biotic community advantageous to trout will establish itself in Craig Creek upon change to cold water. Experiences below Table Rock Dam and below Norfork Dam on the North Fork River, Arkansas, do not indicate that biotic change has been a problem. However, this aspect of environmental change was considered sufficiently important for the Bureau of Sport Fisheries and Wildlife to transplant cold water biota to the Little Red River below Greers Ferry Dam, Arkansas, when a cold water fishery was established. It is important that a cold water biota acclimate to Craig Creek since much of the success of the fishery depends upon sustaining a resident trout population and in achieving "catchable" fish sizes from stocked fingerlings.

Water quality could be a problem on Craig Creek, especially in view of the impetus on summer home development. The standards mentioned previously should be considered minimum, and in all likelihood those which would be based upon possible human uses of the waters would exceed the minimum standard set for trout environment. In any event, the real issue would be enforcement rather than adopted standards.

16. PROJECT COST

The total cost of construction of the Hipes development is estimated to be $23,525,000. This includes $22,500,000 for the dam and reservoir, $706,000 for the downstream trout rearing station, $312,000 for the downstream trout fishery, and $7,000 for archeological survey and salvage.

Estimates of first costs for the dam and reservoir and associated downstream facilities include costs of initial construction, future recreation facilities, contingencies, engineering and design, and supervision and administration. Construction costs were based on detailed layouts shown on Exhibit 4-10 and design considerations discussed in paragraph 11. Unit prices for the cost estimates are based on prices for similar work performed in nearby areas and are adjusted to July 1967 price levels. Contingency allowances amount to 25% of the cost for land acquisition and damages and 20% for other major features. Table 4-21 summarizes the first costs for Hipes Reservoir and associated downstream facilities. Detailed estimates of first costs are shown in Tables 4-23, 4-24, and 4-26 for Hipes Reservoir, downstream trout fishery, and rearing station, respectively.

Total investment costs and annual financial charges were developed for Hipes and associated projects based on data presented in the cost estimates. Investment costs include construction costs plus interest on the initial increment. Interest during construction was determined using an interest rate of 3.25 percent and a construction period of four years for Hipes Reservoir and the trout rearing station. Since the construction period of the trout fishery facilities was assumed to be less than two years, the gross investment is equal to the construction costs. Average annual charges were computed on the gross investment using the current Federal interest rate of 3.25 percent and an amortization period of 100 years. Operation and maintenance charges for the proposed developments are based on current costs of similar projects and include costs for major replacement items where applicable. Financial annual costs are summarized in Table 4-22. Detailed estimates of the annual costs are shown in Table 4-26.

TABLE 4-21
SUMMARY OF FIRST COST
HIPES RESERVOIR AND ASSOCIATED PROJECTS
(July 1967 Prices, $1,000 United)

ITEM	HIPES DAM AND RESERVOIR		DOWNSTREAM TROUT FISHERY CREATED BY HIPES RESER.		TROUT REARING STATION	
	COST	COST WITH INDIRECT COSTS DISTRIB.	COST	COST WITH INDIRECT COSTS DISTRIB.	COST	COST WITH INDIRECT COSTS DISTRIB.
LANDS AND DAMAGES	$ 2,211	$ 2,211	$221	$221		
RELOCATIONS	1,594	1,940				
RESERVOIR	553	673				
DAM AND APPURTENANCES	9,848	11,985				
RECREATION FACILITIES	4,357	5,302(a)	75	91		
PERMANENT OPERATING EQUIPMENT	229	279				
BUILDINGS, GROUNDS AND UTILITIES	114	139			$580	$706
ENGINEERING AND DESIGN	2,003		9		70	
SUPERVISION AND ADMINISTRATION	1,620		7		56	
TOTAL PROJECT COST	$22,529	$22,529	$312	$312	$706	$706
Rounded	$22,500	$22,500	$312	$312	$706	$706

(a) Of this amount $2,664,000 is for initial facilities and $2,638,000 is for future facilities.

TABLE 4-22
SUMMARY OF FINANCIAL ANNUAL COST
HIPES RESERVOIR AND ASSOCIATED PROJECTS

Item	Cost: Hipes Dam and Reservoir	Cost: Downstream Trout Fishery	Cost: Trout Rearing Station
Interest on gross investment	$ 734,800	$10,800	$24,400
Amortization of gross investment	31,300	500	1,000
Maintenance and operation	226,700	6,100	72,100
Major replacements	54,100	800	2,200
TOTAL	$1,046,900	$18,200	$99,700

TABLE 4-23

DETAILED ESTIMATE OF FIRST COST

HIPES RESERVOIR PROJECT
(July 1967 Prices)

Item	Unit	Quantity	Unit Price	Amount
LANDS AND DAMAGES, JOINT USE LANDS				
Surface acquisition				
Improved home, camp, and church sites	Acre	179	$1,000	$ 179,000
Bottom cropland/ pasture	Acre	1,700	200	340,000
Rolling pasture/ woodland	Acre	2,460	100	246,000
Rough woodland	Acre	3,376	30	101,280
Subtotal		7,715		$ 866,280
Improvements	Set	146		620,000
Subtotal, Surface lands and damages				$1,486,280
Contingencies				371,570
Total Surface acquisition				$1,857,850
Summary				
Surface acquisition				$1,857,850
Resettlement Costs				67,000
Acquisition costs				189,600
TOTAL JOINT USE LANDS				$2,114,450
LANDS AND DAMAGES, SPECIFIC USE LANDS (RECREATION)				
Surface acquisition				
Rolling pasture/ woodland	Acre	80	$ 100	$ 8,000
Rough woodland	Acre	996	30	29,880
Subtotal		1,076		$ 37,880
Improvements	Set			24,000
Subtotal, Surface lands and damages				$ 61,880
Contingencies				15,470
Total, Surface acquisition				$ 77,350

TABLE 4-23 (cont'd)

Item	Unit	Quantity	Unit Price	Amount
Summary				
Surface acquisition				$ 77,350
Resettlement Cost				4,500
Acquisition costs				14,400
TOTAL SPECIFIC USE LANDS				$ 96,250
TOTAL LANDS AND DAMAGES				$ 2,210,700
RELOCATIONS				
Highways				
State 615	Mile	7.5	-	$ 1,046,400
State 606 & 612				130,000
Subtotal				$ 1,176,400
Utilities				
Power lines	L.S.			$ 50,000
Telephone lines	L.S.			$ 30,000
Subtotal				$ 80,000
Cemeteries				
Graves	Each	300	-	$ 72,000
Subtotal				$ 1,328,400
Contingencies				265,680
TOTAL RELOCATIONS				$ 1,594,080
RESERVOIR				
Clearing reservoir	Acre	4,400	-	$ 453,600
Archaeological and Historical Survey and Salvage				7,000
Contingencies				92,120
TOTAL RESERVOIR				$ 552,720
DAM AND APPURTENANCES				
Dam and spillway				
Cofferdams and diversion of water	L.S.	1	-	$ 61,000

TABLE 4-23 (cont'd)

Item	Unit	Quantity	Unit Price	Amount
Clearing and grubbing				
Dam site	Acre	50	$1,000	$ 50,000
Borrow areas	Acre	75	200	15,000
Stripping dam	C.Y.	45,000	1.00	45,000
Stripping borrow area	C.Y.	60,000	0.50	30,000
Excavation, cut-off	C.Y.	20,400	1.00	20,400
Foundation preparation cut-off	S.Y.	2,200	2.75	6,050
Compacted fill				
From required excavation	C.Y.	800,000	0.20	160,000
From borrow	C.Y.	1,790,000	0.90	1,611,000
Additional rolling	Hour	200	50.00	10,000
Drilling grout holes	L.F.	19,800	4.50	89,100
Grouting	Bags	19,800	5.35	106,000
Riprap	C.Y.	44,400	5.00	222,000
Topsoiling	C.Y.	4,600	1.25	5,750
Seeding	Acre	11.4	1,300.00	14,820
Pavement on dam	L.S.	1	-	15,700
Guard rail	L.S.	1	-	12,600
Instrumentation	L.S.	1	-	20,000
Clearing				
Spillway	Acre	20	1,000	20,000
Stripping spillway	C.Y.	31,600	1.00	31,600
Excavation, spillway				
Common	C.Y.	438,660	1.25	548,000
Rock	C.Y.	366,800	2.50	917,000
Backfill	C.Y.	5,000	1.15	5,750
Concrete	C.Y.	17,481	35.00	612,000
Gates and Operating Equipment	L.S.	625,200	0.45	281,000
Steel reinforcing	L.S.	175,000	0.19	33,300
Foundation grouting	L.S.	1	-	13,000
Bridge	L.S.	1	-	170,000
Riprap	C.Y.	15,000	12.00	180,000
Subtotal				$5,306,070
Contingencies				1,061,210
Total, Dam and spillway				$6,367,280
Dike between spillway and State highway				
Clearing	Acre	5.4	$1,000	$ 5,400
Stripping	C.Y.	2,220	2.95	6,550
Foundation preparation	S.Y.	6,700	1.00	6,700
Embankment	C.Y.	90,500	1.10	$ 99,550
Riprap	C.Y.	500	5.00	2,500

TABLE 4-23 (cont'd)

Item	Unit	Quantity	Unit Price	Amount
Topsoiling	C.Y.	50	1.25	60
Seeding	S.Y.	600	0.27	160
Drilling grout holes	L.F.	2,000	4.50	9,000
Grouting	Bags	2,000	5.35	10,700
Subtotal				$ 140,620
Contingencies				28,120
Total, Dike between spillway and State highway				$ 168,740
Outlet works				
Control tower				
Concrete	C.Y.	14,000	55.00	$ 770,000
Access bridge	L.S.	1	-	180,000
Main gates and liners	L.S.	1	-	240,000
Bulkheads and guides	L.S.	1	-	14,000
Intake gates (high level)	Each	10	13,100	131,000
Trash racks and guides	L.S.	1	-	10,600
Control slide gates	Each	2	16,500	33,000
Bulkhead hoist	L.S.	1	-	3,000
Vent system	L.S.	1	-	16,000
Elevator	L.S.	1	-	20,000
Electrical system	L.S.	1	-	45,000
Monitoring system	L.S.	1	-	10,000
Remote control	L.S.	1	-	25,000
Conduit and stilling basin				
Excavating	C.Y.	94,000	1.10	103,000
Concrete				
Conduit	C.Y.	15,700	35.00	550,000
Stilling basin	C.Y.	3,000	35.00	105,000
Wing walls	C.Y.	2,750	35.00	96,000
Backfill	C.Y.	5,000	1.15	5,750
Subtotal				$2,357,350
Contingencies				471,470
Total, Outlet Works				$2,828,820
Access Roads				
State highway to spillway	L.S.	1	-	$ 88,000
Spillway to stilling basin	L.S.	1	-	31,000
Access at Biggs Run	L.S.	1	-	84,000
Access at Schoolhouse Branch	L.S.	1	-	200,000
Subtotal				$ 403,000
Contingencies				80,600
Total, Access Roads				$ 483,600
TOTAL, DAM AND APPURTENANCES				$9,848,440

TABLE 4-23 (cont'd)

Item	Unit	Quantity	Unit Price	Amount
RECREATION				
Initial Development				
Facilities cost 1/	L.S.	-	-	$1,824,000
Contingencies				365,000
Total, Initial Development				$2,189,000
Future Development				
Facilities cost 1/	L.S.	-	-	$1,807,000
Contingencies				361,000
Total, Future Development				$2,168,000
TOTAL, RECREATION				$4,357,000
PERMANENT OPERATING EQUIPMENT				
Precipitation stations	Each	3	-	$ 1,400
Office equipment	L.S.	-	-	2,000
Shop equipment	L.S.	-	-	10,000
Diesel-electric generator	Each	1	-	15,000
Instrumentation, stream stage and water quality	L.S.	-	-	18,000
Radio communication facilities	L.S.	-	-	5,000
Stream gaging station	Each	1	-	$ 25,000
Transportation, reservoir and ground maintenance equipment	L.S.	-	-	83,000
Floating plant	L.S.	-	-	5,000
Sedimentation ranges	L.S.	-	-	5,000
Subtotal				$ 169,400
Contingencies				59,300
TOTAL, PERMANENT OPERATING EQUIPMENT				$ 228,700
BUILDINGS, GROUNDS AND UTILITIES				
Administration Building	L.S.	1	-	40,000
Operators quarters	L.S.	2	20,000	40,000
Utilities	L.S.			7,000
Site grading and development	L.S.			8,000
Subtotal				$ 95,000
Contingencies				19,000
TOTAL, BUILDINGS, GROUNDS AND UTILITIES				$ 114,000

1/ See table 4-27 for details.

TABLE 4-23 (cont'd)

Item	Unit	Quantity	Unit Price	Amount
ENGINEERING AND DESIGN				
Initial development	L.S.			$1,743,200
Future development	L.S.			260,200
TOTAL, ENGINEERING AND DESIGN				$2,003,400
SUPERVISION AND ADMINISTRATION				
Initial development	L.S.			$1,409,100
Future development	L.S.			210,300
TOTAL, SUPERVISION AND ADMINISTRATION				$1,619,400

TABLE 4-24

DETAILED ESTIMATE OF FIRST COSTS

DOWNSTREAM TROUT FISHERY
(July 1967 Prices)

Item	Unit	Quantity	Unit Price	Amount
LANDS AND DAMAGES				
Surface acquisition				
Access sites	Site	6	$2,000	$ 12,000
Stream right	Mile	14	2,800	39,200
Subtotal, Surface lands and damages				$ 51,200
Contingencies				12,800
Total, Surface acquisition				$ 64,000
Summary				
Surface acquisition				$ 64,000
Acquisition costs				157,200 (a)
TOTAL, LANDS AND DAMAGES				$ 221,200
RECREATION				
Initial development				
Facilities cost	L.S.			$ 62,200
Contingencies				12,400
TOTAL, RECREATION				$ 74,600
ENGINEERING AND DESIGN				
Initial development	L.S.			$ 9,000
TOTAL, ENGINEERING AND DESIGN				$ 9,000
SUPERVISION AND ADMINISTRATION				
Initial development	L.S.			7,200
TOTAL, SUPERVISION AND ADMINISTRATION				$ 7,200
TOTAL DOWNSTREAM TROUT FISHERY				$ 312,000

(a) Involves approximately 150 tracts

TABLE 4-25

DETAILED ESTIMATE OF FIRST COSTS

TROUT REARING STATION
(July 1967 Prices)

Item	Unit	Quantity	Unit Price	Amount
BUILDING, GROUNDS AND UTILITIES				
Initial Development				
Water supply to aerator	L.S.			$ 81,000
Aerator	L.S.			11,000
Water supply to raceways	L.S.			60,000
Raceways	Each	10	$11,360	113,600
Buildings				
Garage, shop & office building	L.S.			40,000
Visitor center	L.S.			40,000
Residence	L.S.			22,500
Domestic water supply	L.S.			10,000
Sanitary sewer system	L.S.			15,000
Roads & parking	L.S.			48,800
Site preparation & Landscaping	L.S.			20,000
Electric service	L.S.			6,000
Fences	L.S.			10,000
Miscellaneous	L.S.			5,000
Subtotal, Building, grounds and utilities				$ 482,900
Contingencies				96,600
TOTAL BUILDINGS, GROUNDS AND UTILITIES				$ 579,500
ENGINEERING AND DESIGN				
Initial Development	L.S.			$ 70,000
TOTAL ENGINEERING AND DESIGN				$ 70,000
SUPERVISION AND ADMINISTRATION				
Initial Development	L.S.			$ 56,000
TOTAL SUPERVISION AND ADMINISTRATION				$ 56,000
TOTAL TROUT REARING STATION				$ 705,500
ROUNDED				$ 706,000

TABLE 4-26

DETAILED ESTIMATE OF FINANCIAL ANNUAL COST
HIPES MULTIPLE PURPOSE RESERVOIR PROJECT

Item	Hipes Dam and Reservoir	Downstream Trout Fishery	Trout Rearing Station Below Hipes Reservoir
Total Investment			
(1) Recapitulation of project cost			
(a) Initial costs	$19,891,000	$312,000	$705,500
(b) Incremental costs	2,638,000	0	0
(2) Interest during construction (Initial cost only)	1,292,900	0	45,900
(3) Total gross investment	23,821,900	312,000	751,400
Annual Initial Costs			
(1) Interests on gross investment	688,500	10,800	24,400
(2) Amortization	29,300	500	1,000
(3) Maintenance and operation			
(a) Dam and reservoir	45,000	0	0
(b) Recreation	120,000	6,100	72,100
(4) Major replacements			
(a) Dam and reservoir	20,000	0	0
(b) Recreation	22,400	800	2,200
(5) Total initial annual cost	925,200	18,200	99,700
Annual Future Incremental Cost 1/	121,700	0	0
Total Annual Costs	$ 1,046,900	$ 18,200	$ 99,700

1/ See table 4-28 for derivation.

Cost of Reservoir Recreation Features - While it is theorized that recreation use increases with larger conservation pools, additional lands and facilities are required to accommodate this increased on-site demand. Of more importance, the maximum dam elevation and the site development potential must be compatible with topographic conditions. A recreation cost curve was developed.in order to analyze alternative projects of various sizes and select the optimum plan of development. Exhibit 4-31 shows the relationship between various conservation pool elevations and attendent costs of providing roads, lands and recreation facilities.

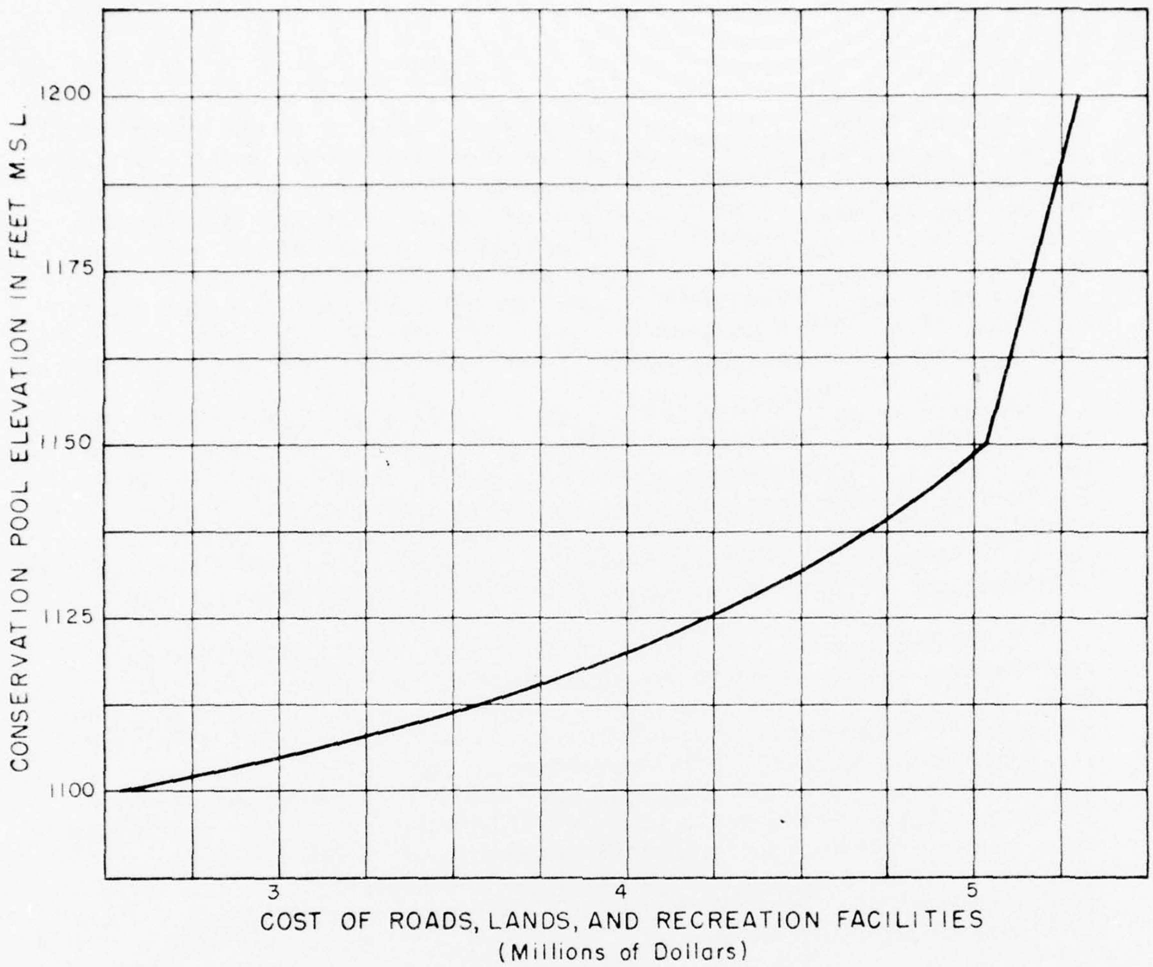
Details of the initial and future first cost of recreation facilities for the formulated plan are presented in Table 4-27. The provision of certain recreation facilities, such as a marina complex and special day-use facilities, has been advocated for private development in the plan described in Section III. Inasmuch as these are expected to be entrepeneurial facilities, neither costs nor benefits associated therewith have been included in analyses of Hipes Reservoir and associated projects.

The annual cost of operation and maintenance of the recreational facilities has been based on an analysis of the reservoir management organization required for the initial and ultimate attendance; the various items of maintenance equipment required and their useful life; and the roads to be maintained for recreation. The cost of replacement of recreation facilities and roads was also determined based on one-third of the facilities being replaced every 25 years over the 100-year economic life of the project. The operation and maintenance for the formulated plan are presented in Table 4-28, which contains a detailed summary of annual charges and benefits for general recreation and fish and wildlife developments at Hipes Reservoir.

Operation and Maintenance of Downstream Trout Fishery and Trout Rearing Station - The Virginia Commission of Game and Inland Fisheries furnished the following estimated annual cost of stocking Craig Creek below the dam. The estimated maintenance costs included upkeep of access spurs into the sites as well as for the parking areas and sanitary facilities.

25,000 fingerling rainbow --	10/lb. at $0.06 each	$1500
15,000 catchable rainbow --	2.5/lb. at $0.60/lb.	3600
	Subtotal	$5100
Maintenance of access areas		1000
	Total	$6100

The estimated operation and maintenance costs of $72,100 annually as developed for the trout rearing station are presented in detail in Table 4-29.



COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

RECREATION COST CURVE
HIPES RESERVOIR

SCALE
AS SHOWN

Drawn by: R.H.B.
Checked by: F.T.W. Date: JANUARY, 1968

Exhibit 4-31

TABLE 4-27

DETAILED ESTIMATE OF GENERAL RECREATION, AND FISH AND WILDLIFE RECREATION COSTS
HIPES RESERVOIR, VIRGINIA

Item	Unit	Unit Cost	Initial Quantity	Initial Amount	Future Quantity	Future Amount	Total Quantity	Total Amount
FACILITIES - General Recreation and Fish and Wildlife Recreation								
Roads								
Access to Oriskany and Crawford Areas	Job	-	Job	$ 754,000	Job	$ 180,000	Job	$ 934,000
Circulation	Mile	$ 35,000	9	315,000	10	350,000	19	665,000
Picnic Units	Each	150	140	21,000	300	45,000	440	66,000
Picnic Shelters	Each	12,000	1	12,000	2	24,000	3	36,000
Camping Units	Each	400	130	52,000	275	110,000	405	162,000
Parking	Job	-	Job	70,000	Job	130,000	Job	200,000
Launching Ramps	12' Lanes	5,000	8	40,000	14	70,000	22	110,000
Water Supply	Job	-	Job	99,000	Job	183,000	Job	282,000
Sanitation	Job	-	Job	171,000	Job	330,000	Job	501,000
Beach-Changehouse	Job	-	Job	100,000	Job	200,000	Job	300,000
Overlooks	Each	5,000	2	10,000	1	5,000	3	15,000
Trails	Mile	5,000	3	15,000	5	25,000	8	40,000
Maintenance yard, equipment, signs and markers	Job	-	Job	110,000	Job	45,000	Job	155,000
Site improvement, Reservoir fishery	Job	-	Job	55,000	Job	110,000	Job	165,000
SUBTOTAL - FACILITIES				$ 1,824,000		$ 1,807,000		$ 3,631,000
Contingencies, @ 20%				365,000		361,000		726,000
SUBTOTAL				$ 2,189,000		$ 2,168,000		$ 4,357,000
Engineering and Design and Supervision and Administration @ 21.7%				$ 475,000		$ 470,000		$ 945,000
TOTAL COST GENERAL RECREATION AND FISH AND WILDLIFE FACILITIES				$ 2,664,000		$ 2,638,000		$ 5,302,000
REAL ESTATE - GENERAL RECREATION								
Land 1/	Acres	$ 100	80	$ 8,000			80	$ 8,000
Rough woodland 1/	Acres	30	996	29,880			996	29,880
Improvements				24,000				24,000
Acquisition and resettlement cost	Job			18,900				18,900
SUBTOTAL				$ 80,780				$ 80,780
Contingencies				15,470				15,740
TOTAL COST REAL ESTATE - GENERAL RECREATION				$ 96,250				$ 96,250
TOTAL COST GENERAL RECREATION AND FISH AND WILDLIFE RECREATION LANDS AND FACILITIES				$ 2,760,250		$ 2,638,000		$ 5,398,250
ROUNDED				$ 2,760,000		$ 2,640,000		$ 5,400,000

1/ Acres above guide-taking line.

TABLE 4-28

DETAILED SUMMARY OF CONSTRUCTION AND INVESTMENT COSTS
ANNUAL CHARGES, ANNUAL BENEFITS AND VISITORS (in 1,000)
GENERAL RECREATION AND FISH AND WILDLIFE RECREATION

HIPES RESERVOIR, VIRGINIA

Item	Initial Increment	Future Increment	Total	Future Increment Discounted	Total with Future Increment Discounted
CONSTRUCTION COSTS					
Facilities - General Recreation, Fish and Wildlife	$ 2,664.0	$ 2,638.0	$ 5,302.0		
Real Estate - General Recreation	96.3		96.3		
Total Construction Costs	$ 2,760.3	$ 2,638.0	$ 5,398.3		
INVESTMENT COSTS					
General Recreation and Fish and Wildlife Construction	$ 2,664.0	$ 2,638.0	$ 5,302.0		
Interest During Construction (4 yrs)	173.2		173.2		
Real Estate - General Recreation	96.3		96.3		
Interest During Construction (4 yrs)	6.3		6.3		
Total Investment General and Fish and Wildlife Recreation Lands and Facilities	$ 2,939.8	$ 2,638.0	$ 5,577.8		
ANNUAL CHARGES - SPECIFIC-USE LANDS AND FACILITIES					
Interest on Investment 1/	$ 95.5			$ 46.3	$ 141.8
Amortization of Investment 1/	4.1			2.0	6.1
Major Replacement 2/	22.4			11.7	34.1
Direct Operation and Maintenance 3/	120.0			61.7	181.7
Loss in Land Productivity 4/	1.4			-	1.4
Total Annual Economic Charges	$ 243.4				$ 365.1
Total Annual Financial Charges	242.0			$ 121.7	363.7
VISITATION (1,000)					
General Recreation	300.0	625.0	925.0		
Fishing (pool)	-	-	68.0		
Total Visitation	300.0	625.0	993.0		
BENEFITS					
General Recreation	$ 450.0	$ 937.5	$ 1,387.5		$ 946.2
Fishing (pool)	-	-	-		66.2
Total Benefits	$ 450.0	$ 937.5	$ 1,387.5		$ 1,012.2 5/

1/ Interest project life 100 years 3.25, amortization .00138, and discount factor .5401.
2/ Major Replacement - Initial Facility Investment x 1/3 x .0252.
Future Increment Facility Investment x 1/3 x .0133.
3/ Operation and Maintenance future increment discounted by .5418.
4/ Loss in Land Production (5.00 - 3.25).
5/ Total benefit discounted by the effect of drawdown.

TABLE 4-29
ESTIMATED OPERATION AND MAINTENANCE COSTS
HIPES TROUT REARING STATION

Item		Total Cost
Fingerlings to Hipes		
206,250 fingerlings at $.06		$12,375
Fingerlings to catchable size		
2.5 fish per lb.		32,625
Station Maintenance		
Station Superintendent and two fish culturists		
Superintendent (salary)	$ 7,000	
2 Fish Culturists at $5,000	10,000	
Travel and Subsistence	3,000	20,000
Maintenance residence, visitors centers, at 2%		1,200
Maintain office, garage, shop and storage building, rearing ponds, and roads and parking at 1%		1,400
Maintain grounds and landscaping (labor included in Station Maintenance above)		200
Heat and Power to Station		1,800
Equipment maintenance, water quality control 3 trucks, etc.		2,500
TOTAL OPERATION AND MAINTENANCE		$72,100

17. DEVELOPMENT COSTS

In evaluating expansion benefits resulting from tourist and recreationist's expenditures within Sub-region C, it was estimated that a period of ten years would be required for the sub-region to realize the full impact of the potential tourist related expenditures. Existing tourist and recreation facilities within the sub-region could accommodate very little of the total estimated expenditure resulting from the estimated recreation visitation. However, it is assumed that within ten years after project construction investments in these type facilities will be great enough so that all expenditures can be credited to the sub-region.

Based on the projected visitation and the estimated expenditures by the recreation users, the investment in facilities to provide for food services, lodging, transportation and miscellaneous services was calculated. Expenditures were converted to employment, using 1963 Census of Business averages, and thence to establishments. The investment costs per establishment were based upon census averages and aggregated to total investment. These facilities are estimated to increase from 0 to $1.6 million within a 25-year period. Assuming a 5 percent return on the investment, average annual charges discounted over the 100-year economic life of the project at 3-1/4 percent are $89,000.

18. SUMMARY

The reservoir and associated downstream projects would provide benefits (both to the nation and the project region) which have been classified into two categories; user and expansion benefits. Subsequent paragraphs of this section describe the procedures and techniques used to measure the benefits creditable to the various elements of the plan. Tables 4-30, 4-31, and 4-32 summarize these benefits by category as well as crediting appropriate values to the national and/or regional account.

TABLE 4-30
DETAILED SUMMARY OF BENEFITS
HIPES RESERVOIR

	ANNUAL BENEFITS ($1,000)				
Category and Class of Benefits	National Account Only	Regional Account Only	National & Regional Acct.	Total National Account	Total Regional Account
User Benefits					
Flood Control	100	-	30	130	30
Water Quality Control	490	-	-	490	-
Recreation	607	-	405	1,012	405
Total User Benefits	1,197	-	435	1,632	435
Expansion Benefits					
Redevelopment	-	215	123	123	338
Gross Development	-	533	160	160	693
*Loss of Income	-	- 11	- 4	- 4	- 15
Total Expansion Benefits	-	737	279	279	1,016
TOTAL BENEFITS	1,197	737	714	1,911	1,451

*Annual Loss of Income from Lands taken for Project.

TABLE 4-31
DETAILED SUMMARY OF BENEFITS
DOWNSTREAM TROUT FISHERY

Category and Class of Benefits	ANNUAL BENEFITS (Dollars) National Account Only	Regional Account Only	National & Regional Account	Total National Account	Total Regional Account
User Benefits					
Recreation	17,100	-	12,000	29,100	12,000
Total User Benefits	17,100	-	12,000	29,100	12,000
Expansion Benefits					
Redevelopment	-	5,900	1,300	1,300	7,200
Development	-	9,000	2,100	2,100	11,100
Total Expansion Benefits	-	14,900	3,400	3,400	18,300
TOTAL BENEFITS	17,100	14,900	15,400	32,500	30,300

TABLE 4-32
DETAILED SUMMARY OF BENEFITS
TROUT REARING STATION

Category and Class of Benefits	ANNUAL BENEFITS (DOLLARS) National Account Only	Regional Account Only	National & Regional Account	Total National Account	Total Regional Account
User Benefits					
Recreation	202,500	-	135,000	337,500	135,000
Total User Benefits	202,500	-	135,000	337,500	135,000
Expansion Benefits					
Redevelopment	-	19,800	5,200	5,200	25,000
Development	-	67,800	17,200	17,200	85,000
Total Expansion Benefits	-	87,600	22,400	22,400	110,000
TOTAL BENEFITS	202,500	87,600	157,400	359,900	245,000

19. USER BENEFITS

The benefits directly resulting from the project functions of flood control, recreation, and water quality control would include (a) flood damage reduction both in and outside Appalachia, (b) general recreation development and fish and wildlife enhancement with attendance expected from other regions as well as locally, and (c) low-flow augmentation for water quality improvement outside the sub-region. The methods used in deriving the estimated user benefits are discussed hereinafter with appropriate tabulations of computations included.

Flood Control - An important user benefit attributable to a water development project results from reduction in flood stages and damages in downstream overflow areas. Evaluation and treatment of damages used to derive flood control benefits attributable to the proposed Hipes Project were determined on the basis of reduction in damages over that afforded by the Gathright Project which is now under construction. Damage data with and without the Gathright Project are included in the summaries to indicate the effect of this project.

Extent and Character of Flooded Area - The studied overflow area of the James River downstream from the considered Hipes Reservoir contains six urban developments, (Eagle Rock, Buchanan, Glasgow, Lynchburg, Scottsville and Howardsville), 15,100 acres of agricultural land and numerous transportation routes. Portions of the major transportation routes that lie on the flood plain are Routes 43 and 11, the Chesapeake and Ohio Railroad, and the Norfolk and Western Railroad. The value of all property located in the flood plain of zones J-2 thru J-5 (shown on Exhibit 4-2) is estimated at about 153 million dollars, as itemized in Table 4-33.

Flood Damages - General - Data used to develop flood damage estimates for the James River are based on either new or previous field surveys brought up-to-date to represent present conditions and values (July 1967 price level). For study purposes, the overflow area which would be affected by the Hipes Reservoir project was divided into seven damage zones as shown on Exhibit 4-2. Flood heights in zone C-1 would be modified only by Hipes Reservoir. Flood heights in all six zones of the James River would be affected by the Gathright and Hipes Projects, with the effect diminishing in the downstream zones (J-6 and J-7). Therefore, the benefits in these zones have not be evaluated. Based on these damage data, the damage which would be caused by a recurrence of the March 1936 flood and a flood having an average recurrence interval of 100 years with Gathright Project in operation, is estimated at $2,945, 000 and $6,716,000, respectively. A detailed breakdown of damages by category for the James River zones affected by the Hipes Project is presented in Table 4-34.

TABLE 4-33

TYPE AND VALUE OF DEVELOPMENT, JAMES RIVER, VIRGINIA

Reach and Item	Units	Value ($1,000)
James River, Reach J-2 (Mile 323.7 to 279.9)		
Agricultural	4600 acres	960
Transportation routes	22 miles	1,808
Residential	94 structures	1,410
Commercial	49 structures	1,994
Industrial	6 structures	42,100
Public	4 structures	165
Subtotal		48,437
James River, Reach J-3 (Miles 279.9 to 250.1)		
Agricultural	375 acres	75
Transportation routes	23 miles	6,449
Residential	-	-
Commercial	20 firms	7,446
Industrial	12 firms	47,896
Dams	5 dams	14,515
Public	2 structures	867
Subtotal		77,248
James River, Reach J-4 (Mile 250.1 to 196.8)		
Agricultural	5600 acres	1,120
Transportation routes	64 miles	14,382
Residential	-	-
Commercial	-	-
Industrial	-	-
Public	-	-
Subtotal		15,502
James River, Reach J-5 (mile 196.8 to 172.8)		
Agricultural	4495 acres	899
Transportation routes	25 miles	1,643
Residential	27 structures	240
Commercial	43 structures	1,302
Industrial	3 structures	7,832
Public	4 structures	68
Subtotal		11,984
Total - Study Area		153,171

TABLE 4-34

DAMAGE FOR RECURRENCE OF SPECIFIC FLOODS, JAMES RIVER, VIRGINIA

Reach and Item	Damage for Flood Recurrence ($1,000) a/ March 1936	100-year frequency
Reach J-2 (Mile 323.7 to 279.9)		
Agricultural	55	78
Transportation routes	190	468
Residential	4	45
Commercial	9	60
Industrial	69	132
Public	0	4
Subtotal	327	787
Reach J-3 (Mile 279.9 to 250.1)		
Agricultural	4	5
Transportation routes	282	390
Residential	0	0
Commercial	176	294
Industrial	1,227	3,322
Dams	7	13
Public	0	0
Subtotal	1,696	4,024
Reach J-4 (Mile 250.1 to 196.8)		
Agricultural	125	146
Transportation routes	426	659
Residential	0	0
Commercial	0	0
Industrial	0	0
Public	0	0
Subtotal	551	805
Reach J-5 (Mile 196.8 to 172.8)		
Agricultural	104	123
Transportation routes	151	244
Residential	14	40
Commercial	94	266
Industrial	1	396
Public	7	31
Subtotal	371	1,100
Total	2,945	6,716

a/ All damage computed assuming Gathright in place.

Residential Damages - In determining residential damages, first floor elevations and other points of zero damage were obtained by field surveys, either new or previous, and the market value of residences was established from assessed valuation furnished by city officials. Having established the market value and first floor elevation, the damage to each residence, together with furnishing, was determined from tables prepared for this purpose. These tables designated the damage to dwellings and furnishings with market value within the range of those found on the flood plain. The tables were prepared by estimating for each property valuation the probable flood damage to floors, walls, heating facilities, furniture, and appliances based on the depth of water over the first floor in a house of such valuation. In addition to the above physical damage, losses to occupants resulting from the inability to utilize living quarters were computed based on four persons per family at $5.00 per person per day for a given number of days depending upon the height and duration of flooding.

Commercial Damages - In determining commercial damages, first floor elevations or other points of zero damage were obtained as indicated for residences. Each commercial establishment was classified as either small, medium, or large. Having established the size and first floor elevations of each establishment, the damage was then determined from tables prepared for the purpose. These tables were the result of detailed studies for specific types of commercial establishments such as drug stores, banks, hardware, mens clothing, offices, restaurant, and etc. For commercial establishments which were not adaptable to this analysis procedure the damages were determined by personal interview, in which each owner or manager was contacted and an estimate made of the losses. The physical loss included the damage to the buildings, including furnishings and fixtures, equipment, stock of raw materials, materials in process, completed products and cleanup. The emergency cost included additional expenses that would not otherwise be incurred. Business and financial losses include the various economic losses such as net loss of normal profit, and wages to employees that must continue during the flood period.

Industrial Damages - Damage to industrial plants was obtained by interviewing the officials of each industry involved. Based on the information furnished, an estimate was made of the damages at varying increments of flood stage. This included the physical damage to buildings, raw material, equipment, and finished products. Included also were the losses from decreased profit and continuing wages and overhead expenses.

Utility Damages - Utility damages were determined by the same method used for estimating the industrial damages. This item includes damage to sewers, gas, municipal filtration plant, electric and power features, and telephone facilities.

Transportation Damages - Flood damages to transportation routes were obtained by interviews with county and state road officials and officials of the Chesapeake and Ohio and Norfolk and Western Railroads. Damage estimates were also supplemented by other pertinent data gathered in previous surveys and adjusted to current price levels.

Crop Damage - Flood damage to agricultural lands was estimated with the assistance of the Soil Conservation Service. Each reach (J-2 through J-5) was evaluated and a stage-damage curve was obtained.

Exhibit 4-32 shows a typical stage-area inundated relationship. From previous and present field surveys, a relationship of crop land to pasture land and the percentage of each crop on the flood plain was established for each reach of river. A composite-acre damage value was computed for the agricultural land. The composite values consist of a weighted ratio of percent damage by depth of inundation to the potential damageable value of the crop distribution in each reach. The values were further weighted with storm distribution from weather and streamflow records, which include the incidence of floods during the growing season.

By using a stage-area inundated curve and the damage rate per composite acre, a stage-damage table was prepared and related to the 1936 flood. Flood plain scour, erosion, and other land damages were computed as part of the direct crop and pasture damage for each reach. Damage to agricultural improvements such as fences, farm roads and other farm improvements were included.

Many areas of the flood plain now produce low returns because of the adverse effects of flooding. The installation of Hipes and a well-regulated flood control program would increase returns. This takes into consideration the increased level of income due to greater production of crops by using improved varieties, larger amounts of fertilizer and other practices made possible by the reduced flood hazard. The difference in the return above production cost for the present level of production and the return expected with the higher level of use is the estimated annual benefit due to more intensive use of the flood plain lands. The open area inundated at various levels is shown on Exhibit 4-32 for zone J-2.

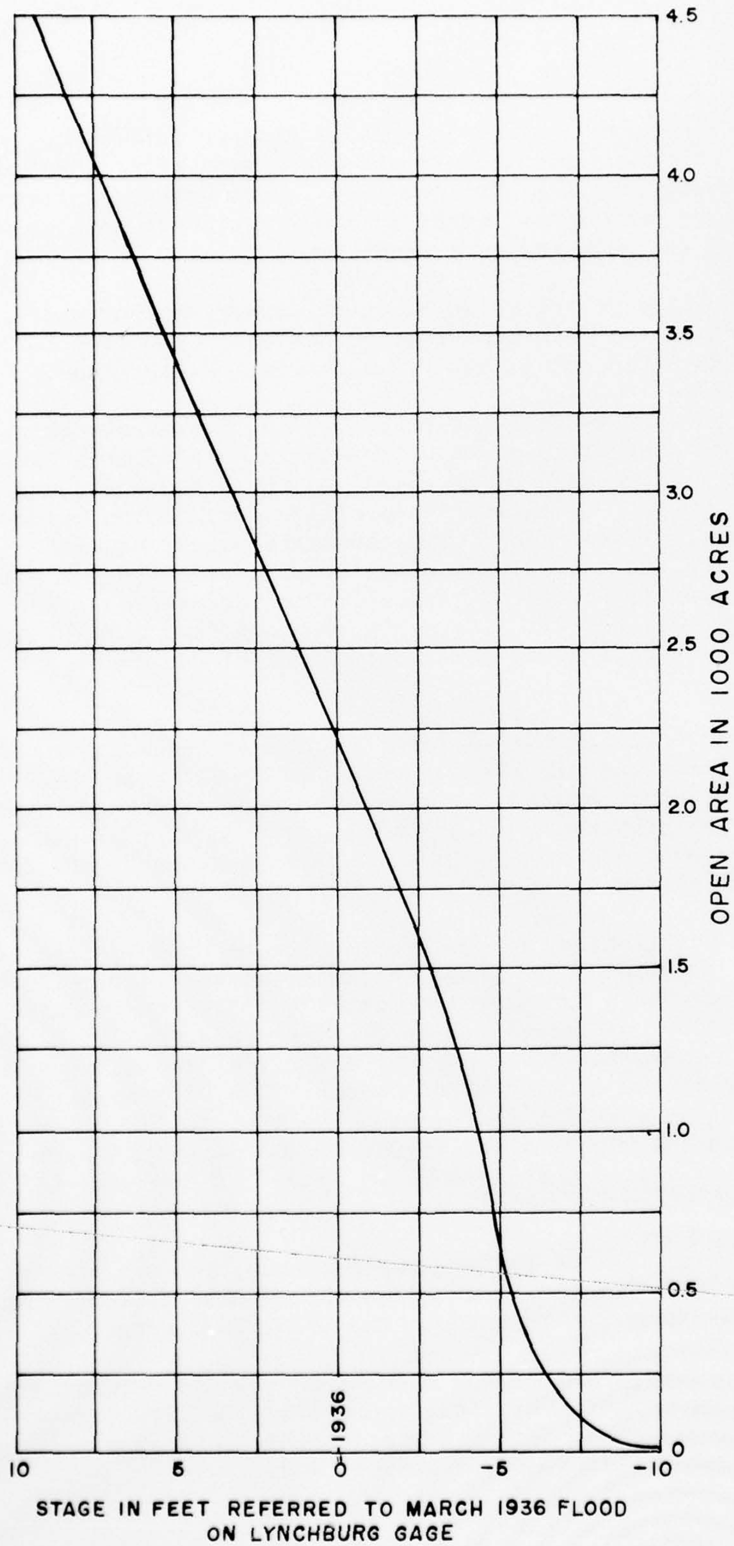
Direct crop damage, damage to farm improvements, and the benefits due to more intensive use of the flood plain were summed to construct a stage-damage table which was related to the 1936 flood stage.

Damage Curves - Damage curves for each reach studied were obtained by summing the residential, commericial, industrial, utility, transportation, and agricultural damages into a composite curve. A sample stage-damage curve for reach J-3 is shown on Exhibit 4-33.

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

STAGE - AREA INUNDATED

JAMES RIVER ZONE J-2



SCALE AS SHOWN

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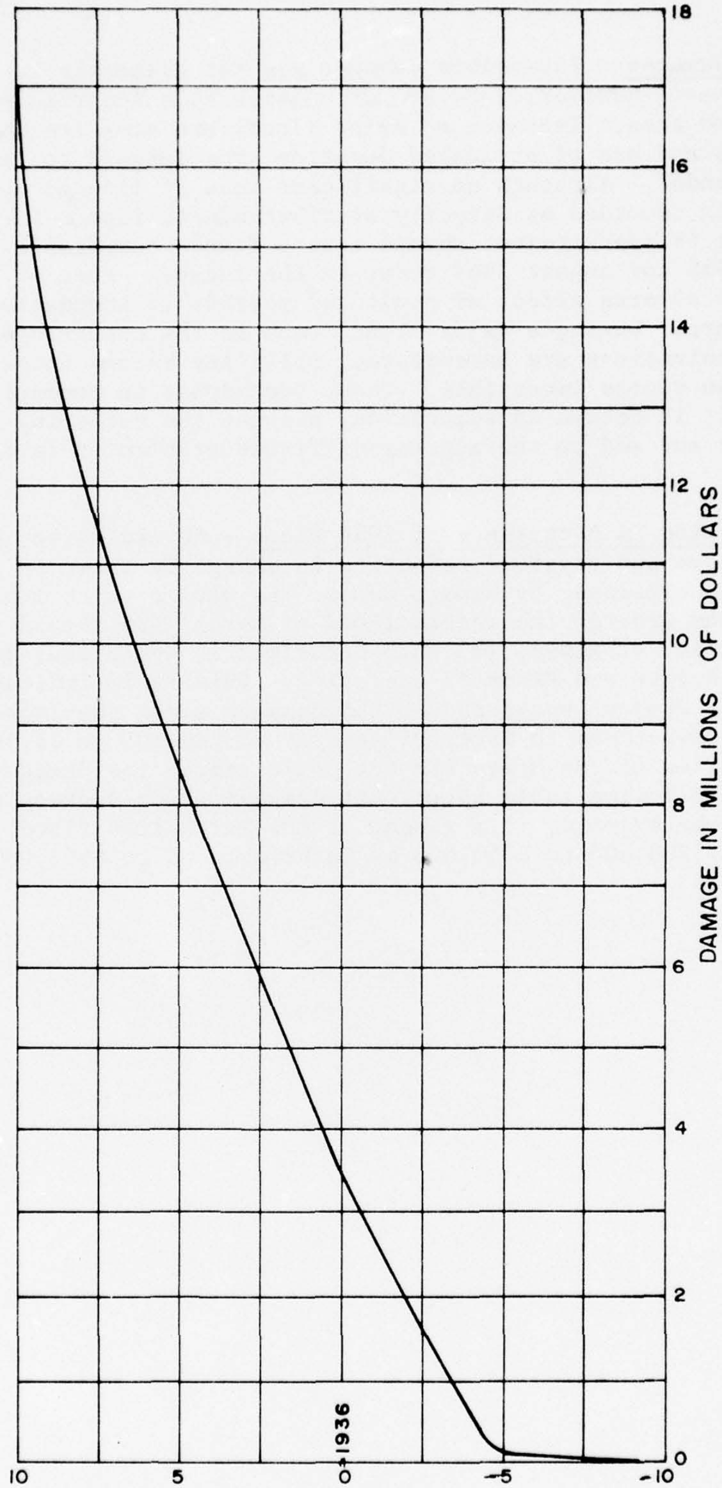


COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

STAGE DAMAGE CURVE
JAMES RIVER ZONE J-3

SCALE AS SHOWN

Exhibit 4-33

Intangible Damages - Intangible damages are not adaptable to monetary measurement; however, they are of considerable importance in the study overflow area. Inasmuch as major floods are more frequent in the winter months and are of prolonged duration, the dangers to life and health are compounded. Although no significant loss of life or epidemic diseases have been recorded as directly attributable to floods in recent years, the danger is ever-present should severe floods comparable to those of March 1936 and August 1969 occur in the future. Also of importance is the adverse effect of prolonged periods of inundation on the general welfare. During a major flood, such as the occurrence of March 1936, communications are interrupted, utilities become inoperative and transportation routes impassible. These breakdowns in communications and service result in delays in evacuation, prevent the rendering of needed assistance and add to the already difficult problem of rehabilitation.

Damage Reduction in Recurrence of 1936 Flood - An indication of the potential damage and possible reduction in damage is shown in Table 4-35 which summarizes, by damage zones, the damage which would result in the study area if the record flood of March 1936 should recur (a) without Gathright or Hipes, (b) with Gathright in operation, and (c) with both Gathright and Hipes in operation. This table indicates that the Gathright Project would reduce the damages along the Jackson and James Rivers downstream to Scottsville from $5,780,000 to $3,068,000 and that the addition of the Hipes Project would reduce the damage to $1,476,000. The following table shows that damages along Jackson and James Rivers in Sub-region C, in a repeat of the March 1936 flood, would be reduced from $1,208,000 to $450,000 by Gathright and to $162,000 by Gathright and Hipes.

TABLE 4-35
SUMMARY OF DAMAGES IN RECURRENCE
OF MARCH 1936 FLOOD

Damage Zone	Damages Remaining in $1,000 Natural	With Gathright	With Gathright and Hipes
Jackson River			
JR-1	135	0	0 (a)
JR-2	129	1	1 (a)
James River			
J-1	267	122	122 (a)
J-2	677	327	39
Subtotal (b)	1,208	450	162
J-3	3,489	1,696	657
J-4	650	551	405
J-5	433	371	252
Total	5,780	3,068	1,476

(a) Not affected by Hipes Project.
(b) Total in Sub-region C.

Future Growth - Benefits will accrue to the proposed projects as a result of normal future development expected to locate on the flood plain in the absence of the water plan. In urban areas the present trend of development on the flood plains was noted. Discussion with local persons, knowledgeable of conditions in specific areas, gave insight to potential growth within these areas. The National Planning Association made economic projections of the entire James River Basin. Of particular importance and use were the NPA population projections by counties for the entire basin. Projections for the Water Sub-region C portion of the basin were applied, although altered where deemed appropriate to reflect local conditions of a specific flood plain area. The estimate of benefits reflects also the increased investment and productivity of existing plant, equipment, and contents on the flood plain. Projections for agricultural areas were made after extensive field surveys by the SCS. These projections are reflected in the estimate of benefits.

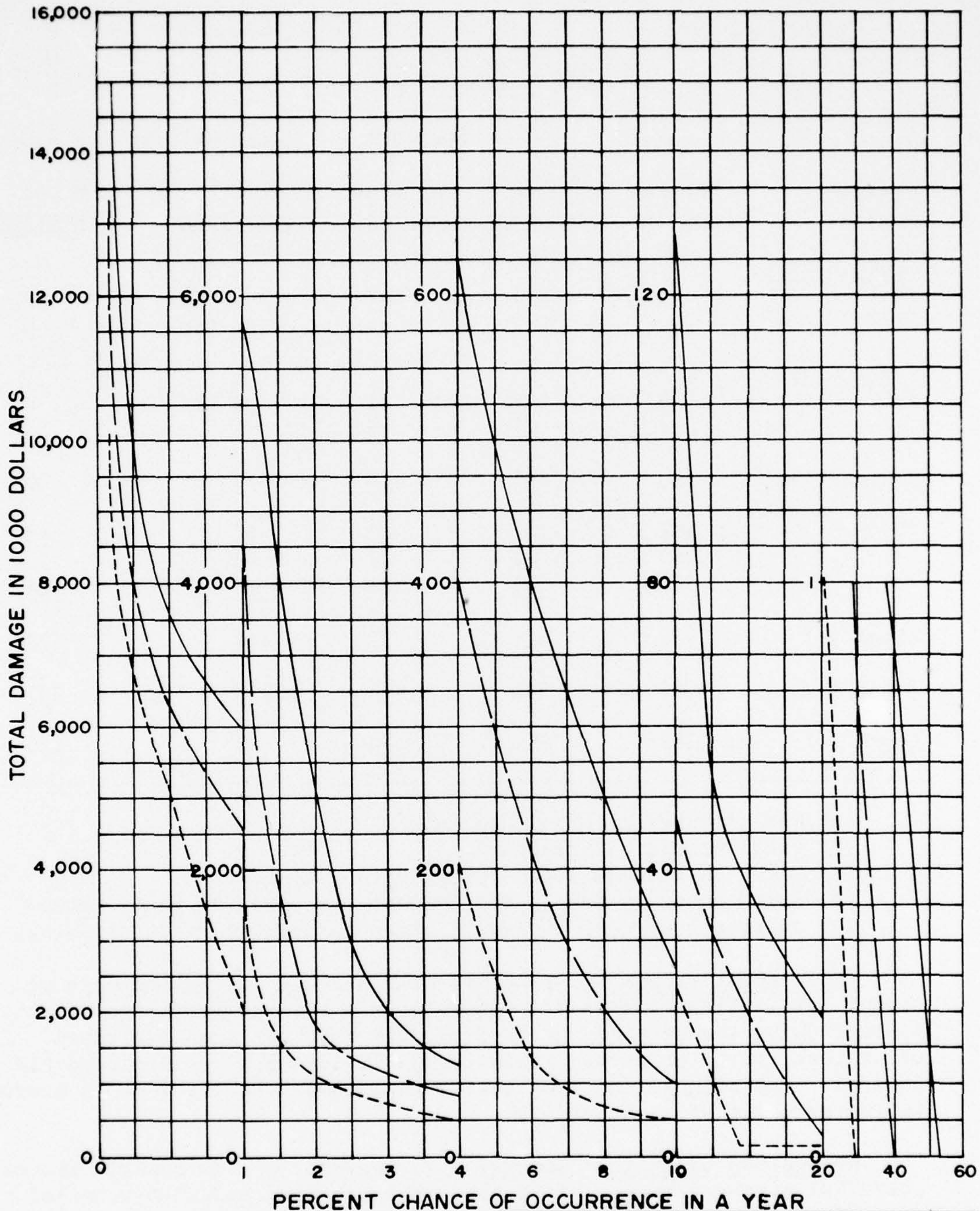
Average Annual Benefits - Flood damages were also evaluated in terms of average annual losses. The difference between the average annual losses, with and without a flood protection project, represents the average annual benefits attributable to the project. This is used in evaluation of the economic feasibility of projects in which the benefits are compared with the cost, which is also expressed on an average annual basis.

Damages are determined on an average annual basis by combining the stage-damage relationship previously described with the stage-frequency relationship corresponding to the control appropriate to the study. Discharge frequencies appropriate to these studies and method of obtaining these frequencies are shown in paragraph 10 of this chapter. Discharges are converted to stages by application to appropriate stage-discharge curves for each of the damage zones concerned. Combination of the stage-damage and stage-frequency relationship, in which the average annual damage can be determined arithmetically or can be determined graphically by integrating the area under the damage-frequency curve, provides a measure of the average annual damages. A typical damage-frequency curve is shown on Exhibit 4-34 for zone J-3.

The average annual benefits used in formulation of a project were based on the flood control benefits averaged over the next 100 years using a discount rate of 3-1/4 percent. This is accomplished by determining the average annual damages (and benefits) (a) based on development on the flood plain increasing gradually from its present state to that expected 50 years hence in the absence of a project and then remaining constant, and (b) averaging these data over the next 100 years. The increase in potential damages by type of property is shown below in Table 4-36. Average annual damages over the next 100 years, by zones, pertinent to the development of flood control benefits attributable to the Gathright and Hipes Project are shown in Table 4-37.

TABLE 4-36
INCREASE IN POTENTIAL DAMAGES
BY TYPE OF PROPERTY

Type of Property	Increase in Potential Damages in 50 Years
Residential	10%
Commercial	10%
Industrial	30%
Highways	20%
All Other	-0-



LEGEND

——— NATURAL

— — WITH GATHRIGHT

- - - - - WITH GATHRIGHT AND HIPES

COMPREHENSIVE PLAN OF DEVELOPMENT
FOR
WATER RESOURCES IN THE APPALACHIAN REGION

DAMAGE FREQUENCY
JAMES RIVER ZONE J-3

Exhibit 4-34

TABLE 4-37
AVERAGE ANNUAL DAMAGES AND BENEFITS
IN $1,000

		With Gathright		With Gathright & Hipes	
Damage Zone	Natural Damages	Damage Remaining	Gathright Benefits	Damages Remaining	Hipes Benefits
Jackson River					
JR-1	107	1	106	1 (a)	0
JR-2	53	7	46	7 (a)	0
James River					
J-1	29	8	21	8 (a)	0
J-2	94	39	55	9	30
Subtotal (b)	283	55	228	25	30
J-3	185	122	63	77	45
J-4	95	71	24	48	23
J-5	110	89	21	65	24
Total (c)	673	337	336	215	122
Total (d)	787	381	406	244	137
Total (e)	729	359	370	229	130

(a) Not affected by Hipes Project.
(b) Total within Sub-region C.
(c) Based on present stage-damage data (Jul 67).
(d) Based on stage-damage relationship expected 50 years hence.
(e) Average over next 100 years based on 3-1/4 percent discount.

Enhancement Benefits - Benefits attributable to the increase or higher utilization of property made possible through provision of flood protection by the proposed Hipes Reservoir have not been evaluated. Uses of property to be protected would change little with the proposed flood control. Accordingly, no substantial enhancement benefits would accrue to the proposed Hipes Reservoir.

Recreation Benefits - General - An analysis of the general recreation potential of the proposed Hipes Reservoir has been made. A detailed breakdown of recreation opportunities and facilities to be provided at the project is presented in paragraph 15 of this chapter. Benefits attributed to general recreation are summarized as follows. Initial attendance at

Hipes is estimated at 300,000 annually. The ultimate attendance is estimated to be 925,000. The assignment of attendance and recreation day values was based upon anticipated conservation pool levels which were expected to affect the recreation experience. Hence, $1.50 per recreation day was attributed to pools with a 5-foot drawdown or less, $1.10 for a 7-foot drawdown, $0.50 for a 10-foot drawdown, and no apprised benefit value for a drawdown greater than 10 feet. Where drawdown exceeds 10 feet it may be difficult to provide water-based recreation facilities as a result of the shoreline topography. The attendance was reduced by an amount varying from "0" for a 5-foot drawdown to 30 percent at a 10-foot drawdown. Average annual equivalent benefits for general recreation are estimated at $946,000.

Fish and Wildlife - The estimated value of the existing fishery and that provided by ultimate development of the reservoir and associated projects is given in the following table. In deriving the net increase in benefits for project conditions the per diem values of the various fishery types were used as follows: trout (cold water) $3.00; reservoir (warm water) $1.25 at elevation 1160, reduced as pool is drawn down; and warm water stream $1.50. The stream above the damsite is considered to be a trout fishery and below the damsite a warm water fishery. Thus, the values of the existing fisheries, which would be destroyed by the project, would partially offset the value of the project fishery.

TABLE 4-38
AVERAGE ANNUAL FISHERY VALUES

Fishery Location	Without Project (man-days)	With Project (man-days)	Net Increase Man-days	Net Increase Fishery Value
Stream above damsite				
(20 miles or 80 acres)	3,600	-	-	-
Reservoir (4,540 acres)	-	71,600	68,000	$66,200
Stream below damsite				
(14.8 miles or 100 acres)	4,800	12,000 1/	7,300	29,100
TOTALS	8,400	83,700	75,300	$95,300

1/ Based on cold water fish that would be stocked by the hatchery.

The trout rearing station is expected to produce about 75,000 pounds of fish annually. The total value of the facility output is $337,500 annually which is based upon the potential annual supply of 112,500 man-days of trout fishing for Virginia streams.

The hunting opportunities under existing conditions would be substantially replaced by those provided at suitable locations in the recreation areas and adjacent areas of Jefferson National Forest. The wildlife values are considered to be equivalent for pre-project and project conditions.

Water Quality Control - An intensive study of the James River was made by the Federal Water Pollution Control Administration to evaluate the present and projected needs for low-flow augmentation for water quality control. The relationship of Sub-region C to the James River Basin is shown on Exhibit 4-1. This study indicated that with adequate treatment of wastes the quality of water in streams would be unsatisfactory at three locations: Covington, Lynchburg, and Richmond. The benefit of raising the quality to satisfactory levels has been taken as equal to the cost of the cheapest means for attaining that end. The most feasible means for raising the water quality to a satisfactory level are low-flow augmentation and/or greater treatment of wastes. The flows required with three levels of waste treatment and the cost of treatment, as estimated by the FWPCA, are shown in Appendix D.

The Gathright Reservoir now being constructed by the Corps of Engineers will provide storage for water quality control sufficient to supply the flow required to about year 2020 at Covington and to about 1980 at Lynchburg and Richmond. Studies reported in Appendix D indicate that the cheapest means of achieving adequate water quality control at Lynchburg and Richmond after 1980 would be as follows:

(a) Construction of a reservoir in 1980 with capacity to provide the flow required at Lynchburg to year 2020 with adequate treatment of waste (removal of 85 percent of 5-day BOD). This reservoir would also supply the flows required at Richmond to 1995.

(b) Construction of advanced waste treatment (removal of 90 percent of 5-day BOD) facilities at Richmond in 1995.

The studies presented in Appendix D were based on providing a storage volume just equal to the difference between the required and the natural flow. While storage volumes computed in this manner are considered reasonable for comparing alternative plans, they would not be adequate to meet the needs under practical operating conditions. The storage reservoirs would be upstream from the needs points and low-flow releases would require from several days to about two weeks to reach the point of need. Reservoir releases would be based on a forecast of runoff from the uncontrolled area rather than the actual runoff available and would therefore necessitate reservoir storages greater than shown in Appendix D. In addition, there would be a loss in streamflow resulting from the removal of water for irrigation. After adjusting the storage from the uncontrolled area, it was concluded that if a reservoir were constructed to meet the needs at Lynchburg to year 2020 advance waste treatement of wastes at Richmond should begin 1990 instead of 1995. Using the cost of these facilities as a measure, the water quality control benefit of Hipes Reservoir is $490,000 per year.

User benefits of the Hipes Reservoir and its associated projects are summarized in Table 4-39.

TABLE 4-39
SUMMARY OF USER BENEFITS
($1,000)

Item of Benefit	Hipes Reservoir	Downstream Trout Fishery	Trout Rearing Station
Flood Control			
Present	122	-	-
Future	8 (a)	-	-
Recreation			
General	946	-	-
Fish and Wildlife	66	29	338
Water Quality Control	490	-	-
TOTAL BENEFITS	1,632	29	338

(a) Discounted to present worth 3-1/4%.

20. EXPANSION BENEFITS

Expansion benefits are divided into two categories, redevelopment and developmental. Redevelopment benefits consist of wage payments made to persons employed in the construction, operation and maintenance of the water resource plan. Developmental benefits are measured in terms of wage payments made to persons not directly associated with the project, but whose employment results from the economic activity induced by the project.

Redevelopment Expansion Benefits - Redevelopment benefits credited to the regional account consist of the average annual equivalent of all labor used in construction, operation and maintenance of the water resource plan. Benefits credited to the national account are the wage payments made to persons who would otherwise be unemployed or underemployed in the absence of the project and who possess the necessary skills required for the project construction.

Detailed analyses of construction costs of various reservoirs indicate labor costs to be about 35 percent of project construction costs

excluding lands and damages, permanent operating equipment, engineering and design, and supervision and administration. Further analysis was made to determine the degrees of skill required in project construction and what portion of these labor skills could be furnished from the locally unemployed or underemployed. The results of these studies are presented in the following table:

TABLE 4-40
LABOR SKILL REQUIRED FOR CONSTRUCTION, OPERATION AND MAINTENANCE OF PROJECT

Item	Labor Required %	Supplied Locally %	Redevelopment factor National Account	Redevelopment factor Regional Account
Construction				
Skilled	30	5	.015	.30
Semi-skilled	29	50	.145	.29
Unskilled	41	100	.410	.41
TOTAL	100		.570	1.00
Operation and Maintenance				
Skilled	40	5	.02	.40
Semi-skilled	30	50	.15	.30
Unskilled	30	100	.30	.30
TOTAL	100		.47	1.00

The following table presents a summary of redevelopment expansion benefits credited to the regional and national accounts:

TABLE 4-41
SUMMARY OF REDEVELOPMENT EXPANSION BENEFITS - HIPES RESERVOIR

Item	Expenditure	Labor Costs(a)	Annual Redevelopment Benefits National Account(b)	Annual Redevelopment Benefits Regional Account (c)
Construction				
Initial	$14,298,000	$5,004,000	$ 92,000	$164,000
Deferred	2,168,000	759,000	1,000	14,000
Sub-total	$16,466,000	$5,763,000	$ 93,000	$178,000
Annual Operation and Maintenance	$ 227,000	$ 159,000	$ 29,000	$159,000
Total Benefits			$122,000	$337,000

(a) Labor cost is estimated to be 35 percent of construction costs less lands and damages, permanent equipment, engineering and design; 70 percent of operation and maintenance expenditures.

(b) Using 3-1/4% interest rate and the appropriate redevelopment factor, future benefits were discounted to reflect a 20-year time horizon.

(c) Discounted where applicable for 3-1/4% interest rate and accelerated growth curve for future expenditures.

Redevelopment benefits would also result from the construction of the associated trout rearing station and the downstream trout fishery. These benefits are estimated on the same basis as described in preceding paragraphs for Hipes Dam construction. The following table shows annual redevelopment benefits attributable to the rearing station and downstream fishery.

TABLE 4-42
SUMMARY OF REDEVELOPMENT EXPANSION BENEFITS -
TROUT REARING STATION AND DOWNSTREAM FISHERY

	Expenditure		Labor Costs		Annual Redevelopment Benefits			
					Trout Rearing Station		Downstream Fishery	
Item	Trout Rearing Station	Down-stream Fishery	Trout Rearing Station	Down-stream Fishery	Nat'l. Acct.	Reg'l. Acct.	Nat'l. Acct.	Reg'l. Acct.
	$	$	$	$	$	$	$	$
Construction	579,500	(b) 312,000	240,000	45,500	4,500	8,000	900	1,600
O & M	(a) 17,000	(a) 5,600	17,000	5,600	700	17,000	400	5,600
TOTAL					5,200	25,000	1,300	7,200

(a) Labor Component only.
(b) $221,000 of expenditure is for lands and damages.

Developmental Expansion Benefits - Developmental expansion benefits included in this report are measured in terms of wages and salaries stemming from (a) expenditures made by recreationists and tourists within the sub-region, and (b) economic activity induced by the respending of wages by person involved in project construction, operation and maintenance. The national account reflects the wages and salaries of persons who in the absence of the water resource development and accompanying private recreation development would otherwise be unemployed or underemployed. The regional account includes all wages and salaries accruing within the sub-region as a result of the water resource project and accompanying private development.

Expenditures made by recreationists and tourists within the sub-region require both the water resource development and investment in commercial recreation and tourist related facilities.

It is estimated that the proposed Hipes Reservoir with its water related recreation will attract 300,000 visitors initially to an ultimate visitation of nearly one million over the life of the project.

The following tabulation shows the average local expenditures per visitor, conservatively derived from numerous studies and reports 1/:

1/ "Suggested Application of Recreation as an Industry," a report by Robert R. Nathan Associates, Inc., paragraph 4, page 2.

TABLE 4-43
AVERAGE EXPENDITURE PER VISITOR

Distance from Hipes Reservoir (miles)	Percent of Total Visitation	Daily Expenditure Per Visitor	Weighted Expenditure Per Visitor
0-25	40	$0.50	$0.20
26-50	25	$1.00	$0.25
51-75	15	$2.00	$0.30
over 75	50	$4.00	$0.80
	Average expenditure per visitor		$1.55

Applying Bureau of Outdoor Recreation's estimate of distance of residence of visitors from Hipes Reservoir site, results in an average expenditure of $1.55 per visitor.

To estimate net expansion effects it is necessary to determine the portion of total expenditures that accrue as wages and salaries to persons engaged in providing goods and services to recreationists and tourists. The remaining portion of the visitor's expenditure would represent an estimate of costs incurred, other than wages and salaries, in providing these goods and services by proprietors.

Study Report 24 of the Outdoor Recreation Resources Review Commission indicates approximately 24 percent of visitor expenditures accrue as wages and salaries to individuals. Appropriate county income multipliers, as contained in the study entitled, "Recreation as an Industry," prepared by Robert R. Nathan Associates, Inc., December 1966, were applied to estimated expenditure by counties within the sub-region.

In order to determine what portion of the visitor expenditure would be allocable to each county, the location of the proposed Hipes Reservoir within the sub-region was evaluated and its relationship to surrounding counties was taken into consideration. Supporting factors such as the counties' economic base as suggested by their respective multipliers were taken into consideration. Accordingly, total expenditures per county were estimated and multiplied by the appropriate income multiplier. Table 4-44 lists by county the average value of recreationist's expenditure accruing as wages and salaries.

It is estimated that a period of 10 years would be required for the sub-region to realize the full impact of visitor expenditures. Existing tourist and recreation facilities within the sub-region could accommodate not more than 10 percent of the total estimated expenditure. However, it is believed that within ten years after project construction, investments in facilities of these types will be great enough so that all claimed expenditures can be creditied to the sub-region.

Within the five-county area of the sub-region the potential labor supply in 1965 was over 3,000 persons consisting chiefly of persons outside the labor force, males from agriculture, unemployed persons, and annual new entrants. Unemployed labor resources exist in adjoining Virginia and West Virginia counties which would be available to the sub-region.

TABLE 4-44
AVERAGE VALUE OF RECREATIONIST'S EXPENDITURE
ACCRUING AS WAGES AND SALARIES

County	Average expenditure per visitor	Percent accruing to wages and salaries	Amount accruing to wages & salaries	Percent accruing by county (b)	Amount accruing by county	County (a) Multipliers	Total
Alleghany	$1.55	24	$.37	40	$.15	1.68	$0.25
Botetourt	1.55	24	.37	40	.15	2.01	0.30
Craig	1.55	24	.37	10	.04	1.69	0.07
Average value of expenditure accruing as wage and salary							$0.62

(a) Source: Recreation as an Industry, a report prepared for the Appalachian Regional Commission, by Robert R. Nathan Associates, Inc., Dec 1966, page 130.

(b) Does not total to 100 percent since 10 percent of expenditure accruing outside of Appalachian Region.

Based on the above, it is assumed that of total wages paid to employees of recreation service-type industries such as motels, restaurants, concessions, etc., initially almost all would have been unemployed. Over a period of 20 years, however, it is assumed that the area would gradually approach full employment. Accordingly, developmental benefits credited to the national account are discounted to reflect this full employment condition.

The following table shows estimated average annual developmental benefits creditable to national and regional accounts:

TABLE 4-45
SUMMARY OF DEVELOPMENTAL BENEFITS
HIPES RESERVOIR

	Average Annual Benefits	
Item	Total National Account	Total Regional Account
Recreation Expansion	$ 60,000	$424,000
Redevelopment Expansion	100,000	268,000
Total Developmental Benefits	$160,000	$692,000

Additional developmental benefits would also result from the associated trout rearing station and downstream fishery. About 120,000 visitor days annually will result from the provision of the rearing station and downstream fishery. These benefits are estimated on the same basis as described in preceding paragraphs for Hipes Reservoir and are shown in the following table.

TABLE 4-46
SUMMARY OF DEVELOPMENTAL BENEFITS
TROUT REARING STATION AND DOWNSTREAM FISHERY

Item	Average Annual Benefits			
	Total National Account		Total Regional Account	
	Trout Rearing station	Downstream fishery	Trout Rearing station	Downstream fishery
Recreation Expansion	$12,000	$ 800	$60,000	$ 3,900
Redevelopment Expansion	5,200	1,300	25,000	7,200
Total Developmental Benefits	$17,200	$2,100	$85,000	$11,100

To arrive at net development benefits, an adjustment must be made to reflect incomes which could reasonably be expected from the projected use, in the absence of the project, of lands which are taken for project purposes.

Approximately 30 percent of the reservoir area is cleared and the remainder is wooded. The woodland is cut over, with second growth stands of low marketable value. The cleared land is generally of marginal quality and is devoted mainly to pasture, with some cropping for livestock feed production. No significant change in land use is foreseen in the absence of the project.

Discounting the value of lost income on the above described lands results in an average annual loss of $15,000 over the life of the project. The fair market value of lands and improvements was assumed to be based on an annual return of 5 percent. An adjustment of $33,900 per year to reflect the difference between this rate and the project rate is shown under project costs as a land productivity loss.

SECTION VI - ECONOMIC ANALYSIS

21. ECONOMIC DATA

Project Costs - Annual economic charges were computed utilizing data developed in the cost estimates presented in Section IV of this chapter. These charges differ slightly from the financial annual charges computed for Hipes Reservoir and the downstream fishery, but are the same for the trout rearing station. The difference results from allowing for loss of land productivity which is based on 5 percent annual net income on lands and improvements taken for the projects. A summary of economic costs for Hipes Reservoir and associated projects is shown in Table 4-47.

TABLE 4-47
ECONOMIC COSTS FOR HIPES PROJECT
(July 1967 Prices)

Item	Hipes Reservoir	Downstream Trout Fishery Created by Hipes	Trout Rearing Station	Total
CONSTRUCTION COST (a)				
Land and damages	$ 2,211,000	$221,000		
Relocations	1,940,000			
Reservoir	673,000			
Dam and appurtenances	11,985,000			
Recreation facilities	5,302,000 (b)	91,000		
Permanent operating equipment	279,000			
Buildings, grounds, and utilities	139,000		$706,000	
Total	$22,529,000	$312,000	$706,000	$23,547,000
ANNUAL CHARGES				
Interest at 3-1/4%	$ 734,800	$ 10,800	$ 24,400	$ 770,000
Amortization in 100 years	31,300	500	1,000	32,800
Maintenance and operation	226,700	6,100	72,100	304,900
Major replacements	54,100	800	2,200	57,100
Land productivity loss	33,900	300	0	34,200
Total	$ 1,080,800	$ 18,500	$ 99,700	$ 1,199,000

(a) Cost shown includes cost of engineering, design, supervision and administration

(b) Of this amount $2,664,000 is for initial facilities and $2,638,000 is for future facilities.

Public Investment Program Costs - Annual charges for this feature amount to $89,000, based on a total public investment of $1,630,000. Discussion concerning procedures used to develop the estimated cost of public investment is presented in paragraph 17.

Annual economic benefits developed and discussed in Section V are summarized in Table 4-48.

TABLE 4-48
SUMMARY OF ANNUAL BENEFITS ($1,000)
FOR HIPES DEVELOPMENT 1/

Type of Benefit	Hipes Reservoir		Downstream Trout Fishery		Trout Rearing Station		Total	
	Nt'l.	Reg.l.	Nt'l.	Reg'l.	Nt'l.	Reg'l.	Nt'l.	Reg'l.
User	1,632	435	29	12	338	135	1,999	582
Redevelopment	122	337	1	7	5	25	128	369
User plus Redevelopment	1,754	772	30	19	343	160	2,127	951
Development	156	677	2	11	17	85	175	773
Expansion (Redevelopment plus Development)	278	1,014	3	18	22	110	303	1,142
TOTAL BENEFITS	1,910	1,449	32	30	360	245	2,302	1,724

1/ For more detailed breakdown and discussion of annual benefits see Section V.

22. INDICES OF PERFORMANCE

One index of performance can be evaluated by reliance on the conventional ratio of benefits to costs generally developed for water resource projects. The numerator contains annual user benefits plus those employment benefits attributable to direct construction and operation of the water projects (redevelopment benefits). The denominator is the annual economic cost of the water projects. Such an index, computed below, expresses the minimum index of performance in regard to national income augmentation.

(1)	Hipes Reservoir	$\frac{1,754,000}{1,080,800}$	=	1.62
(2)	Downstream Trout Fishery	$\frac{30,000}{18,500}$	=	1.62
(3)	Trout Rearing Station	$\frac{343,000}{99,700}$	=	3.44
(4)	Total Water Plan	$\frac{2,127,000}{1,199,000}$	=	1.77

Another index of performance gives a relative measure of the contribution that the Hipes development would make to the objective of employment expansion. The numerator consists of increased wage payments for construction and operation of the water project plus wages and salaries and other income flows to the region generated by the associated private investments. The denominator is the annual cost, both public and private, necessary to provide the expansion in employment opportunities.

Hipes Reservoir and Associated Downstream Development $\frac{\text{Increased Wages}}{\text{Annual Cost}} = \frac{1,142,000}{1,288,000} = 0.89$

23. ALLOCATION OF COSTS

Costs of the Hipes Reservoir project were allocated by the separable cost-remaining benefit method, the separable cost of each user purpose being allocated to that purpose and the joint costs allocated to user purposes plus regional income expansion. A description of the projects used to estimate separable cost and alternate cost is given in Table 4-49. A summary of costs for these projects is given in Table 4-50. Cost allocation by the separable costs remaining benefits method for the Hipes Reservoir is presented in Table 4-51.

The costs allocated to recreation have been sub-allocated between general and fish and wildlife recreation programs in Table 4-52.

TABLE 4-49
DESCRIPTION OF PROJECTS USED FOR ESTIMATING
SEPARABLE AND ALTERNATE COSTS

Basis for Separable Cost	Basis of Alternate Cost
FLOOD CONTROL	
Reservoir at the Hipes site with maximum conservation pool elevation 1160 and top of gates at elevation 1162. Optimum recreational development.	Single-purpose reservoir at the Hipes site with 4.2" of flood control storage above the stream bed.
WATER QUALITY CONTROL	
Reservoir at the Hipes site with stable pool at elevation 1138 plus 4.2" of flood control storage. Optimum recreational development.	Single-purpose reservoir at the Stone House site with 85,000 acre-feet of water quality control storage plus advanced treatment of waste at Richmond beginning in 1990.
RECREATION	
Reservoir at the Hipes site with maximum conservation pool elevation 1132 plus 4.2" of flood control storage. No recreational land or facilities.	State park type recreational development.
REGIONAL EXPANSION	
The recommended multiple-purpose development at the Hipes site without the developmental plan.	Single-purpose state park type development and the developmental plan plus an adjustment to make the redevelopment benefit of the alternate equal to that of the reservoir plan.

TABLE 4-50

COST ALLOCATION STUDIES
(Summary of Costs, $1,000)

	Multiple-Purpose Reservoir						Alternate Single-Purpose Project				Multiple-Purpose Project Less			
	Specific-Use Lands & Facilities			Joint-Use Lands & Facilities	Reg'l. Income Expansion	Total Costs	Flood Control	Water Quality Control	Recreation	Reg'l. Income Expansion	Flood Control	Water Quality Control	Recreation	Reg'l. Income Expansion
	Flood Control	Water Quality Control	Recreation											
CONSTRUCTION FIRST COST														
Hipes Project														
Lands and damages			96	2,115		2,211	1,450				2,045	2,011	1,860	2,211
Relocations				1,940		1,940	732				1,900	1,863	1,842	1,940
Reservoir & Pool preparation				673		673	309				673	505	478	673
Dam & appurtenances				11,985		11,985	9,500				11,160	11,000	10,720	11,985
Recreation facilities			2,664			2,664					2,664	2,664		2,664
Buildings, grounds & utilities				139		139					139	139	139	139
Permanent operating equipment				279		279					279	279	279	279
Total initial			2,760	17,131		19,891	11,991				18,860	18,461	15,318	19,891
Future recreation facilities			2,638			2,638					2,638	2,638		2,638
Public Investment Program					1,630	1,630					1,630	1,630	1,630	
Total construction costs			5,398	17,131	1,630	24,159	11,991				23,128	22,729	16,948	22,529
INVESTMENT COSTS														
Hipes Project														
Initial construction costs			2,760	17,131		19,891	11,991				18,860	18,461	15,318	19,891
Interest during construction			179	1,114		1,293	780				1,225	1,200	995	1,293
Investment cost initial increment			2,939	18,245		21,184	12,771				20,085	19,661	16,313	21,184
Future recreation facilities			2,638			2,638					2,638	2,638		2,638
Public Investment Program					1,630	1,630					1,630	1,630	1,630	
Total Investment Costs			5,577	18,245	1,630	25,452	12,771				24,353	23,929	17,943	23,822
ANNUAL FINANCIAL CHARGES														
Initial increment														
Interest and amortization			100	618	89	807	433				770	756	642	718
Operation and maintenance														
Recreation			120			120					120	120		120
Dam				45		45	37				44	43	43	45
Major replacements														
Recreation			22			22					22	22		22
Dam				20		20	20				20	20	20	20
Total initial increment			242	683	89	1,014	490				976	961	705	925
Future Increment (Discounted)														
Interest and amortization			48			48					48	48		48
Operation and maintenance			62			62					62	62		62
Major replacements			12			12					12	12		12
Total future increment			122			122					122	122		122
Total Annual Financial Charges			364	683	89	1,136	490	490 1/	669 2/	945	1,098	1,083	705	1,047

1/ Single-purpose reservoir plus advanced treatment at Richmond.
2/ State park type developments.

TABLE 4-51

ALLOCATION OF COSTS ($1,000), SEPARABLE COSTS - REMAINING BENEFITS METHOD, HIPES RESERVOIR

Item	User Effects: Flood Control	User Effects: Water Quality	User Effects: Recreation	Regional Expansion	Total
1. Benefits	130	490	1,012	1,014	2,646
2. Alternate costs	490	490	669	945	2,594
3. Benefit limits	130	490	669	945	2,234
4. Separable costs	38	53	431	89	611
5. Remaining benefits	92	437	238	856	1,623
6. Allocation of restricted joint costs					
a. Remaining benefits	0	437	238	0	675
b. Ratio		0.647	0.353		1.000
c. Allocated restricted cost		47	26		73
7. Separable plus allocated restricted costs	38	100	457	89	684
8. Remaining benefits	92	390	212	856	1,550
9. Ratio	0.059	0.252	0.137	0.552	1.000
10. Allocated joint cost	27	114	62	249	452
11. Total allocated financial cost	65	214	519	338	1,136
Allocation of Operation, Maintenance and Replacement Cost					
12. Separable O.M.&R. charges	1	2	218	0	221
13. Allocated joint O.M.&R. charges	4	15	8	33	60
14. Total allocated O.M.&R. charges	5	17	226	33	281
Allocation of Investment Costs					
15. Annual investment costs	60	197	293	305	855
16. Capitalized investment costs	. 771	5,815	8,648	8,005	24,239
17. Adjustment for discount on future increment	0	0	1,213	0	1,213
18. Total allocated investment costs	1,771	5,815	9,861	8,005	25,452
Allocation of Construction Costs					
19. Investment in specific-use lands and facilities	0	0	5,577	1,630	7,207
20. Investment in joint-use lands and facilities	1,771	5,815	4,824	6,375	18,245
21. Interest on joint-use lands and facilities	108	355	262	389	1,114
22. Allocated construction cost of joint-use lands and facilities	1,663	5,460	4,022	5,986	17,131
23. Construction cost of specific-use lands and facilities	0	0	5,398	1,630	7,028
24. Total allocated construction cost	1,663	5,460	9,420	7,616	24,159
25. Construction cost of future increment	0	0	2,638	0	2,638
26. Construction cost of Development Plan				1,630	1,630
27. Construction cost of Project (initial)	1,663	5,460	6,782	5,986	19,891
28. Total construction cost of Project	1,663	5,460	9,420	7,616	24,159

TABLE 4-52
HIPES RESERVOIR PROJECT
RECREATION-APPORTIONMENT

	($1,000)
Separable Cost of Recreation	
Cost of Multiple-Purpose Project	22,529
Cost of Multiple-Purpose Project Less Rec.	15,318
Separable Costs of Recreation	7,211
Lands	96
Facilities	5,302
Storage	1,813
Total	7,211

Allocated Construction Costs for Recreation

Recreation	Benefits	Ratio	Allocated Construction Costs ($1,000)
General	966	.690	6,500
F & W	433	.310	2,920
	1,399	1.000	9,420

SECTION VII - COST SHARING

24. GOVERNING LEGISLATION

Apportionment of costs for the multiple-purpose Hipes Reservoir between Federal and non-Federal interests is made according to the following criteria and summarized in Table 4-53.

a. All costs allocated to flood control are apportioned to the Federal Government in accordance with Section 201 of the Flood Control Act of 1958 (P.L. 85-500). The effects of the project are widespread in the sense of economic impact over the study area and along the James River as far downstream as Scottsville.

b. All costs allocated to water quality control are apportioned to the Federal Government according to the Water Pollution Control Act of 1961 (P.L. 87-88). Widespread benefits accrue to the project because of the economic impact of the project services in the James River at Lynchburg and vicinity as well as at Richmond.

c. All costs allocated to recreation for Hipes Dam and Reservoir are apportioned to the Federal Government according to the Federal Water Project Recreation Act (P.L. 89-72). This act states:

> "That it is the policy of the Congress and the intent of this Act that . . . (c) project construction agencies shall encourage non-Federal public bodies to administer project land and water areas for recreation . . . unless such areas . . . are appropriate for administration by a Federal agency as a part of the national forest system. . ."

The recreation areas at Hipes Reservoir will be appropriate for administration by the U. S. Forest Service as part of the National Forest system. The Corps of Engineers and the U. S. Forest Service will cooperatively plan the initial recreation development and the U. S. Forest Service will construct the recreation facilities and administer all of the land and water recreation areas of the Hipes Reservoir project. Excluded will be the trout rearing station, downstream fishery and visitor facilities at the damsite. Besides the administration, the Forest Service will also be responsible for planning and constructing additional recreation facilities as required by the future demand for expansion.

Downstream Trout Fishery - The downstream trout fishery associated with and created by Hipes Reservoir would include (1) the acquisition of such easement as may be necessary for the right use of the stream bed and banks from the dam to the mouth of Craig Creek, and (2) acquisition and improvement of six access areas of about two acres each for parking and boat launching. Provision of this fishery would be subject to the non-Federal participation requirements of the Federal Water Project Recreation Act of 1965 (P.L. 89-72). The State would be responsible for

the construction of the needed facilities and the first costs associated with development of the fishery would be divided between Federal and non-Federal interests on a 50-50 basis. Non-Federal interests are apportioned all operation and maintenance costs associated with this feature, including stocking of trout and all other aspects of a fish management program.

Trout Rearing Station - The associated trout rearing station is a significant enhancement feature of the Hipes Reservoir project. This development consists of an aerator, raceways, office building, shop, garage, residence, and a visitor center and facilities required to use Hipes Reservoir for water supply. Provision of this rearing station would be subject to non-Federal participation requirements of the Federal Water Project Recreation Act of 1965 (P.L. 89-72). This station would be constructed by the State on federally acquired reservoir project land and the first costs associated with this station would be divided between Federal and non-Federal interests on a 50-50 basis. Non-Federal interests are apportioned all operation and maintenance costs associated with the station, including the provision of replenishment trout stock.

25. APPORTIONED COSTS

A summary of the apportionment of costs between Federal and non-Federal interests is presented in the following table:

TABLE 4-53
APPORTIONMENT OF COSTS BETWEEN FEDERAL AND
NON-FEDERAL INTERESTS FOR HIPES RESERVOIR, AND ASSOCIATED PROJECTS

	Construction Costs ($1,000)			Annual Operation Maintenance, and Replacement Charges ($1,000)		
Item	Federal	Non-Federal	Total	Federal	Non-Federal	Total
Hipes Reservoir	22,500	0	22,500	280.8	0	280.8
Downstream Fishery	156	156	312	0	6.9	6.9
Trout Rearing Station	353	353	706	0	74.3	74.3

26. STATE AND LOCAL ASSURANCES

There are no requirements of local cooperation by cost sharing on the Hipes Dam and Reservoir to be constructed by the Corps of Engineers. The entire project costs are allocated to flood control, water quality control, and recreation and would be apportioned as Federal costs. The

initial recreation development will be by the Corps of Engineers with administration by the Forest Service in connection with the management of the Jefferson National Forest.

Prior to construction of Hipes, local interests should furnish assurances that they will:

a. Establish lines along Craig Creek downstream of Hipes to prevent encroachment or development that is incompatible with efficient reservoir operation.

b. Establish and enforce such waste treatment measures and control as may be required to maintain the water in Craig Creek below Hipes Dam suitable for a trout fishery.

c. Exercise, to the full extent of their legal capability, control against removal of streamflow made available for water quality control.

Downstream Trout Fishery - In connection with providing a trout fishery downstream from Hipes Dam:

a. Pay fifty percent of first cost such acquisition as may be necessary for the right of use of the Craig Creek stream bed and banks up to and including the ordinary high water line from the proposed Hipes Dam to the mouth of Craig Creek. Also, pay fifty percent of the cost of acquiring and providing improvements to six access areas of about two acres each for parking and boating launching. The cost of these items to non-Federal interests is presently estimated at $156,000.

b. Assume all operation and maintenance costs associated with a above and responsibility for a fish management program, including the stocking of necessary trout in Craig Creek. The cost of this item is estimated as $6,900 annually.

Trout Rearing Station - In connection with the trout rearing station downstream from Hipes Dam:

a. Pay fifty percent of the cost of providing a trout rearing station below the dam, to include buildings, structures, visitor facilities, and all appurtenances thereto. The cost of these items to non-Federal interests is presently estimated at $353,000.

b. Assume all operation and maintenance costs, presently estimated at $74,300.

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SECTION VIII - COORDINATION IN PLANNING

27. FEDERAL AGENCIES

During planning, studies were coordinated with the Federal Departments of Agriculture; Commerce; Interior; and Health, Education and Welfare; the Federal Power Commission, and the Appalachian Regional Commission, either directly by the Norfolk District of the Corps of Engineers or through the Water Development Coordinating Committee for Appalachia (WDCCA), as appropriate. The investigations were coordinated with the studies underway for the comprehensive development of the water resources of the James River Basin, and with other water resource plans.

Many Federal agencies such as the U. S. Geologic Survey, Environmental Science Service Administration, and the Office of Business Economics provided basic data for project planning, such as climatologic, streamflow, and economic records through regular publications or special reports. Other Federal agencies participated indirectly by assisting the state and local agencies and planning groups. For instance, the Farmers' Home Administration and the Economic Development Administration assisted by providing financial and technical assistance.

Several agencies made special studies as an aid in formulation and evaluation of the plan of development for Craig Creek. Reports of these agencies are included in the appropriate appendices to this report. The following paragraphs present recommendations or views of participating agencies, and actions taken.

Bureau of Outdoor Recreation - BOR surveyed the recreation market area and determined that the demand for recreation opportunities, present and future, exceeds the capabilities of the recreation developments of the project area. BOR cooperated with the Corps of Engineers in the selection of the nine sites adjacent to the reservoir and the formulation of the initial recreation development plan and in the analysis of the effect of reservoir drawdown on the value of the recreation experience. The Corps of Engineers allocated the reservoir storage to limit the drawdown to enhance the recreation benefits of the project.

Federal Water Pollution Control Administration - The FWPCA investigated the conditions in the James River Basin and concluded that no water supply storage was needed but that the present and future waste load of the James River was greater than the assimilative capacity of the streamflow at certain locations. FWPCA also evaluated alternative methods for water quality control to determine the benefits of storage for this purpose in Hipes Reservoir. Subsequently, storage was allocated in Hipes Reservoir to supply water needed for water quality control, considering the optimum balance of benefits for this purpose and for recreation.

Forest Service - The U. S. Forest Service collaborated in initial recreation planning, concurred in the suggestion that the recreation development was appropriate for Federal administration, and agreed to administer it in connection with Jefferson National Forest. Recreation

development plans in the reservoir area were coordinated with the Forest Service and the construction of the recreation facilities and administration of these areas, exclusive of visitor facilities at the damsite, will be turned over to them as well as the responsibility for future planning and construction, as the demand increases.

Bureau of Mines - The BOM inventoried the mineral resources of this area, in connection with the project study. Their report concludes that the only known mineral resources are low grade iron ore deposits which would not support a profitable mining operation. Except for the proposed preservation of an abandoned development (see next paragraph) and allowance for acquisition costs of mineral reservations, expected to be minor and within the contingency allowance, the proposed Hipes Reservoir project would be unaffected by mineral resource considerations.

National Park Service - The National Park Service cooperated with Commonwealth and Corps of Engineers personnel in investigating the project area to determine the quantity and quality of the sites and materials of historical or archaeological importance. It was recommended that the Roaring Run Mine and Furnace located about five miles north of the damsite be preserved and maintained as a historical site and that other sites in the reservoir area were of sufficient interest to warrant excavation and interpretation prior to inundation. The estimated cost of investigation, excavation, and interpretation of these sites was added as a project cost, but the site of the mine and furnace is considerably beyond the project boundaries so its preservation is not considered appropriate for inclusion as a project expense item.

The objectives of the National Park Service are:

(a) Preservation and enhancement of areas of unique scenic, archeological, historic, and natural science values.

(b) Improvement of land and water quality management.

(c) Consideration of structural and non-structural measures, beneficial flow regulation, and flow regulation storage.

In addition to the above; Public Law 89-665, the National Historic Preservation Act of 1966 requires that any Federal or Federally assisted undertaking in any state take into account its effect on any historic site or structure listed in the National Register of Historic Places. The National Register of Historic Places is a list of properties significant to the nation, to the states, and to local areas because of significance in history, architecture, archaeology, and culture.

Studies by the National Park Service to carry out these objectives will be requested by, and coordinated with the appropriate office having responsibility for construction of this project. These studies will be requested when advanced engineering and design for the project is initiated.

Soil Conservation Service - The SCS performed studies which led to the recommendation of the construction of the authorized control structures of the Johns Creek project above Hipes Reservoir and accelerated application of land treatment measures in the Craig Creek watershed. The control structures would modulate the streamflow from about 31 square miles and these project elements would augment the beneficial effects of the Hipes project. The Corps of Engineers concurred in this recommendation.

Fish and Wildlife Service - The Bureau of Sport Fisheries and Wildlife of the F&WS studied the Craig Creek area to evaluate the man-days of fishing and hunting afforded by the stream and its contiguous area, and other recreation days based on existing recreation sites. The Bureau found that a nearby tract considered for acquisition to mitigate the loss of hunting opportunities in the project area was unsuitable and would not increase wildlife production. The Bureau recommended stocking the reservoir and development of adjacent recreation areas to facilitate fisherman access, installation of a trout rearing station below Hipes Dam, development of the downstream trout fishery, and permitting hunting on project lands, including tracts acquired specifically for recreation development, consistent with wildlife population and safety of other recreationists. The normal diminution of general recreation activities during the colder seasons when hunting activity is generally highest would tend to diminish the conflicts with other recreationists and this hunting opportunity would partially offset the loss due to project construction. The Corps of Engineers concurred in these recommendations and included suitable facilities in the plan of initial development of the lakeside recreation areas as well as cooperating in planning of the associated downstream projects, the trout rearing station and downstream fishery. The U. S. Forest Service, as the administrative agency for the land and water recreation areas of the Hipes Reservoir project, would be responsible for formulation of regulations to permit hunting in such areas and at such times as would be consistent with safety and other recreation activities.

Federal Power Commission - The Federal Power Commission found that there is a large demand for power in Power Supply Area 18, which includes Water Sub-region C. In the formulation for the plan of development for Hipes Reservoir, the Corps of Engineers analyzed several plans with hydropower installations. The FPC reviewed these studies and, in their letter of 19 April 1968, concurred that the installation of conventional or pumped storage facilities is not justified. This letter is included in Exhibit 4-35.

28. STATE AGENCIES

The Commonwealth of Virginia has many agencies and departments which assisted in the study and report by providing information and data used in the development of the plan. The Division of Water Resources of the Department of Conservation and Economic Development, Division of Industrial Development, Division of Planning, State Water Control Board, Commission

C O P Y

FEDERAL POWER COMMISSION
REGIONAL OFFICE

730 Peachtree Building
Atlanta, Georgia 30308
April 19, 1968

District Engineer
Corps of Engineers
Department of the Army
Post Office Box 119
Norfolk, Virginia 23501

Dear Sir:

This refers to Mr. C. J. Robin's letter of April 5, 1968, your file NAOEN-R, concerning the installation of conventional and pumped-storage power facilities at the Hipes project at mile 14.8 on Craig Creek in the James River basin. Mr. Robin requested our appraisal by April 23 of the desirability of installing power facilities initially or making provisions for their future installations.

We have reviewed your letter with eight exhibits. You have analyzed eight plans with integral pumped storage at the Hipes project. Four plans with installations of 75,000, 100,000, 150,000 and 200,000 kilowatts would have the afterbay at mile 7.9. The four other plans would have the same installations but the afterbay would be at mile 4.5.

We note that all multiple-purpose plans with pump storage as a purpose were economically feasible, but not financially feasible. Following are your data reporting the financial feasibility of pumped storage for Plans 1, 2, 3, and 8.

	Pump Storage			
	Plan 1	Plan 2	Plan 3	Plan 8
Separable cost of power, $1,000	1,289	1,634	2,517	3,350
Alternate cost of power, $1,000	834	1,111	1,167	2,224
Ratio, alternate cost of power to separable cost of power	.06	0.7	0.7	0.7

As stated in our letter of December 13, 1967, we found that conventional power facilities at the Hipes project are not economically feasible. Our preliminary studies and your investigations show that the installation of pumped-storage power facilities is not financially feasible. Accordingly, we concur with your conclusion that the installation of conventional or integral pumped-storage facilities

C O P Y

initially, or making provision for their installation in the future, is not justified.

Very truly yours,

/s/ Robert C. Price

Robert C. Price
Regional Engineer

of Outdoor Recreation, Commission of Game and Inland Fisheries, and State Departments of Agriculture and Health, all contributed to the development of the plan. Views of the Commonwealth of Virginia, as expressed by the Director of the Department of Conservation and Economic Development, are presented in Section IX of this chapter.

The Commission of Game and Inland Fisheries played an especially prominent role in the formulation of plans for the downstream fishery and trout rearing station associated with the Hipes Reservoir project. Other agencies also participated in the planning to assure compatibility of the Hipes Development with other elements of State plans of development.

29. LOCAL GROUPS

Valuable assistance in the development of the plan was received from many special purpose districts organized under State law as legal entities of the State for specific geographic areas. Included in this group were soil conservation districts.

The local groups listed as endorsing the project at the public hearing of 14 December 1967 were among the most active and enthusiastic participants in the evolvement of the project plan. Their intense interest is a very strong indication of the success of the project and probable entrepreneurial developments which will result in overall expansion benefits substantially greater than those used in the economic analysis of the project.

30. PUBLIC HEARINGS

Public hearings were held during 1965 in connection with the comprehensive study of the James River Basin to obtain firsthand knowledge of conditions and problems in the Basin and to secure suggestions for their solution. Throughout the study of the James River Basin liaison has been maintained with interested groups and agencies by means of conferences and committee and advisory group meetings.

A public hearing was held by the District Engineer at Fincastle, Virginia on 14 December 1967 for the purpose of affording interested persons opportunity to express their views on preliminary plans presented for the development of the water resources in Sub-region C and specifically for considering the Hipes project. A total of 225 persons were present at the hearing. The hearing was well attended and included representatives of Federal, State, and local governing bodies, representatives of firms and industries, and interested private citizens in and adjacent to the sub-region. Statements were made by interested parties that were both favorable and unfavorable to construction of the proposed Hipes project, the second major reservoir proposed for Sub-region C. A number of property owners affected by the proposed project expressed their opposition toward the project. The following were favorable toward the project:

Board of Supervisors of Botetourt County
Board of Supervisors of Craig County (two of the three members)
Town of Fincastle
Town of New Castle
Town of Buchanan
Town of Troutville
City of Lynchburg
City of Richmond
Botetourt County Chamber of Commerce
Izaak Walton Leaque of America, Chapter No. 1
James River Basin Association
Richmond James River Association
Buchanan Ruritan Club
Botetourt County Community Action Council
Sixty-three citizens of Craig County
Owens - Illinois Co.
Buchanan Sporting Club

31. PROCEDURES FOR PLAN IMPLEMENTATION

Conversion of the plan of development for Craig Creek, as proposed herein, to a reality will require very close coordination on the part of at least three construction agencies and several agencies who will have to prepare detailed supporting studies. Under present conditions the best foreseeable procedure for implementing the plan is outlined below.

The Corps of Engineers will assume overall responsibility for coordinating and implementing the plan. These plans will constitute a joint Master Plan of the Forest Service and Corps of Engineers. For purposes of implementation, the plan can be divided into five basic parts as follows:

a. Land acquisition for the entire plan.

b. Construction of Hipes Dam and Reservoir and initial recreation facilities.

c. Construction of trout rearing station and downstream fishery facilities.

d. Preparation of joint Master Recreation Plan and construction of ultimate recreation development associated with Hipes Reservoir.

e. Operation and maintenance of the constructed works.

The Corps of Engineers would acquire all lands necessary for the plan which are not now in public ownership. The limits of acquisition will be determined after consultation with the U. S. Forest Service and the Commonwealth of Virginia. The Corps will construct Hipes Dam and Reservoir. All appropriate recreation facilities around the reservoir will be constructed by the U. S. Forest Service, exclusive of the visitor facilities at the damsite. Operation and maintenance of the dam and appurtenant structures will be the responsibility of the Corps.

A master plan for recreation development of Hipes will be worked out with the U. S. Forest Service to insure orderly development of the reservoir. The Service will construct additional recreation facilities as they are needed and will operate and maintain the initial facilities as well as those they will construct after project completion.

The Commonwealth of Virginia through its appropriate agencies will construct both the trout rearing station and the necessary downstream fishery facilities. Operation and maintenance of these plan components will be the responsibility of the Commonwealth.

SECTION IX - CONCLUSIONS

32. CONCLUSION

The management of the streamflow of Craig Creek to alleviate flood damages, to provide water for water quality control, to provide water-based recreation opportunities, and to provide the products of related land and water management is required to sustain and enhance the economic well-being in Sub-region C as well as in portions of the James River Basin outside the sub-region. The plan of development of the lower forty miles of Craig Creek as developed in this chapter has taken note of foreseeable water resource needs and has provided as many solutions to those needs as appear at this time to be economically feasible. This development is only one element in the total water resources plan for both the Appalachian Region and the James River Basin.

The development of Craig Creek consists essentially of three parts: (a) construction of a multiple-purpose reservoir; (b) construction of a trout rearing station, and (c) provision of access points for development of downstream fishery along Craig Creek. The foregoing is estimated to have a total construction cost of 23.5 million dollars. This is equivalent to an annual value of 1.2 million dollars which include costs for operation and maintenance. It is estimated that this investment will create an associated investment of approximately 1.6 million dollars. Benefits for the objective of increasing national income are estimated at approximately two million dollars annually. Benefits that would have regional impact are estimated to be 1,142,000 dollars annually.

Implementation of the plan for development of Craig Creek as outlined in this chapter will require the joint efforts of the U. S. Army Corps of Engineers, the U. S. Forest Service, and the Commonwealth of Virginia. These three construction agencies will need help in the advanced planning process from several other Federal agencies such as the Bureau of Outdoor Recreation and the U. S. Fish and Wildlife Service.

The Commonwealth of Virginia has reviewed the proposed plan of development and is generally in agreement with it. The views of the Commonwealth are attached in Exhibit 4-36.

COMMONWEALTH OF VIRGINIA

DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT

911 EAST BROAD STREET
RICHMOND, VIRGINIA 23219

December 16, 1968

Colonel John C. H. Lee, Jr., Director
Office of Appalachian Studies
Corps of Engineers
Department of the Army
Post Office Box 1159
Cincinnati, Ohio 45201

Dear Colonel Lee:

We have completed our review of the draft report on the proposed Hipes Multi-Purpose Reservoir on Craig Creek in Botetourt County, Virginia. In general, we are completely in favor of the Hipes Project and feel it will be of significant benefit to Virginia, particularly so to the Appalachian Region; therefore, we hope that the Corps of Engineers will proceed toward implementation of the project as rapidly as possible.

Following Congressional authorization of the Project, we desire that the Corps of Engineers, in the definite project planning study, work together with other interested State and Federal agencies in review of the present plan in a coordinated effort to determine the optimum physical level of development and method of operation most beneficial to the needs of the basin as developed in the yet to be completed James River Comprehensive Plan.

Specifically, the present draft report lists seven items for which assurance of non-Federal cooperation will be required. These are listed in paragraph 26. The Commonwealth's position on each, in order as they appear in the report, is contained in the following paragraphs.

With reference to the establishment of encroachment lines along Craig Creek to prevent encroachment which would be incompatible with efficient reservoir operation, we must advise that the establishment of such lines, in our opinion, can be effected only by the governing body of the local political subdivision where such encroachment lines would be established. Please know that we will assist in preventing encroachment that would be incompatible with the efficient operation of the Reservoir.

J. C. H. Lee, Jr., Director

With respect to waste treatment measures and measures required to prevent removal of stream flow released from reservoir storage needed to maintain water quality in the stream below the reservoir, it will be the policy of the State Water Control Board to exercise all legal authority to assure the protection of Craig Creek as a trout fishery when it is established or when it appears that it will be established. The State Water Control Board has no authority to regulate or control removal of stream flow made available for water quality control; however, the Board recommends, and will continue to do so, that the flows below the Hipes Dam either as a result of the construction of the Dam itself or the withdrawal of water below the Dam be such that at all times the existing standards of water quality will be maintained.

With regard to providing a downstream trout fishery in Craig Creek below the Dam, the State does intend to participate and will pay up to 50 percent of the cost for the necessary lands and facilities. Operation and maintenance will be the State's responsibility.

The State intends to participate in establishing a trout rearing station immediately below Hipes Dam. The State will pay up to 50 percent of the cost of establishing that station and assume all responsibility for its operation and maintenance.

Sincerely yours,

M. M. SUTHERLAND
Director

MMS:ewd